February 10, 1958 75 Cents

AVIATION WEEK

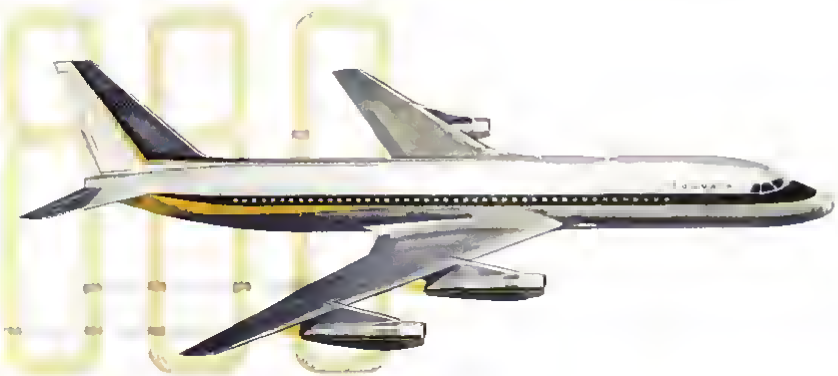
A McGRAW-HILL PUBLICATION

Holloman's Longest Rocket Sled Track

•

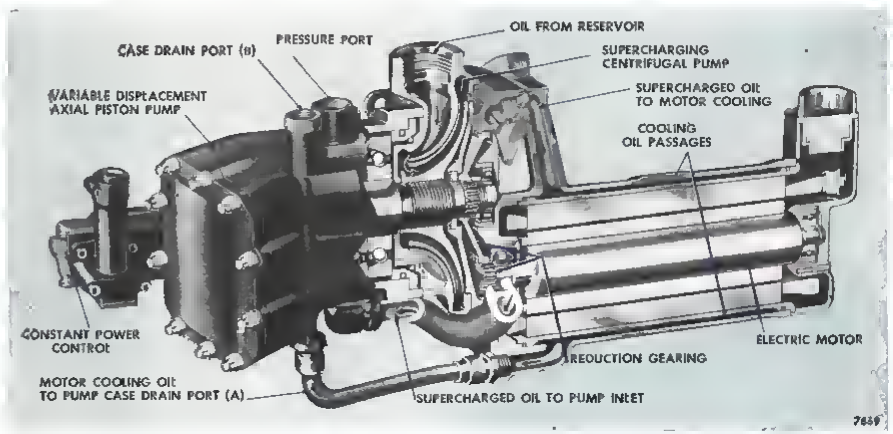
Production Details Of Lockheed F-104

Lockheed F-104 in Production



New Vickers OIL COOLED Motorpump

For Continuous Duty Applications



Installed weight approximately 25% less; also offers significant size reduction

The 12 horsepower oil cooled motorpump shown above weighs 31½ lb and is 20" long overall. motor diameter is less than 4". This represents a substantial saving in weight and size over the conventional air cooled motorpump. Also, there is a further saving with the elimination of duct work in the airframe normally required for air cooling the electric motor. The motorpump illustrated *is now in quantity production* for turbine powered transports.

The time-proven Vickers variable displacement piston type pump, which is an integral part of this "package" delivers up to 8 gpm at 2250 psi, reduces to 6 gpm at 2950 psi and zero flow at 3000 psi. These flow and pressure combinations (8 to 6 gpm range) provide constant horsepower for a variety of flight operating requirements. It is designed for *2000 hour* service.

A centrifugal boost pump is located between the pump and the 400 cycle, 200 v electric motor, in addition to supercharging the pump, it circulates oil through the double-walled motor casing. Cooling oil from the motor jacket is discharged into one case drain port (A) . . . then out port (B) to a heat sink. At full pump flow, the impeller provides 2 gpm to the motor casing.

• The 12 horsepower unit described above is typical of the Vickers motor and pump combinations now available to the aircraft industry as "packaged power" for continuous duty applications. Remarkable records for reliability in both military and airline service have been established by Vickers designed motorpumps.

Higher Overall Efficiency

Overall motorpump efficiency (hydraulic power output to electric current input) is 75%. This is possible only because Vickers Piston Pumps have an overall efficiency of 92%. The more efficient pump means the use of a smaller, lighter electric motor, minimum heat transfer to the hydraulic circuit, and less current drain.

Heat Rejection Control

The oil cooled motor design offers a definite advantage in that heat dissipated (140 Btu per minute, maximum) can be conveyed readily to a remotely located heat sink. This is one reason why optimum performance for a given weight and size is more readily achieved in a liquid cooled unit.

High Altitude Operation

Motor operation is not affected by low air density since it is not dependent upon air cooling. Inclusion of centrifugal boost pump prevents piston pump cavitation above 30,000 ft, even though reservoir is vented to atmosphere.

Constant Power Control

The constant horsepower control shown on the above unit is optional, depending on the application. The control maintains constant 3000 psi pressure as flow increases until the electric motor is loaded to its maximum horsepower. Additional flow is then available at reduced pressure to maintain the same horsepower load on the motor. This type of control is particularly advantageous for low force, high capacity (flow) and high force, low capacity applications while staying within the limits of recommended electric motor load ratings.

Packaged Unit

The axial piston pump, centrifugal boost pump, reduction gear and electric motor are all integrated into an exceptionally compact and high-performance package. This concept also permits a high degree of design flexibility to meet individual requirements.

Sound Insulated

Because air ducts are not needed to dissipate motor heat the oil cooled motorpump can be sealed in a compartment and effectively sound insulated.

Additional Advantages

Low frictional starting torque characteristics of the 12 horsepower unit permit acceleration to maximum speed in less than 200 milliseconds. The electric motor meets the military specifications for explosion-proof operation.

For further information contact the nearest office listed below.

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AVIATION CALENDAR

Feb. 10-14—American Society for Testing Materials Committee Week. Hotel Statler, St. Louis, Mo.

Feb. 17—1958 Conference of Professional Divisions. American Society of Mechanical Engineers. Theme: International Geophysical Year—Technology at the Threshold. Hotel Huntington Sheraton, Pasadena, Calif.

Feb. 19—Are Flying Saucers Fact or Fancy? Dr. Hugh Wm. Missile and Ordnance System Department, GE. Engineers Club, Philadelphia, Pa.

Feb. 20-21—Transistor and Solid-State Circuits Conference. Irvine Auditorium and University Museum, University of Pennsylvania, and Hotel Sheraton, Philadelphia, Pa.

Mar. 3-6—Third Annual American Society of Mechanical Engineers Gas Turbine Conference and Exposition. Shoreham Hotel, Washington, D. C.

Mar. 4—"The Long History of Space Travel," Dr. Willy Ley. The Franklin Institute, Philadelphia, Pa.

Mar. 4-6—Sixth Annual Air Line Pilots Assn., Air Safety Forum. Hotel Shoreland, Chicago, Ill.

Mar. 5-6—Second Annual Shock Tube Symposium. Palo Alto, Calif. For details write: Commander, Air Force Special Weapons Center, Kirtland AFB, N. M. Attn: R. R. Brukoff, SWRS.

Mar. 13-14—Institute of the Aeronautical Sciences National Flight Propulsion Meeting (Secret clearance required). Hotel Carter, Cleveland, Ohio.

Mar. 13-14—Fifth Annual Heat Transfer Technical Conference. Oklahoma State University, Stillwater, Okla.

Mar. 13-14—Second National Conference on Aviation Education. Hotel Mayflower, Washington, D. C.

Mar. 17-20—Joint Aviation Conference.

(Continued on page 6)

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AVIATION CALENDAR

(Continued from page 4)

American Rocket Society, American Society of Mechanical Engineers, Statler Hilton Hotel, Dallas, Tex.

Mar. 17-21—1958 Nuclear Congress, 25 W. 45 St., New York City.

Mar. 17-21—14th Annual Conference, National Assn. of Corrosion Engineers, Civic Auditorium, San Francisco, Calif.

Mar. 17-27—International Aeronautical Federation, 51st General Conference, Los Angeles, Calif. For details write International Aeronautical Federation, 6 rue Cahlee, Paris 16e, France.

Mar. 18-19—Conference on extremely high temperatures (over 30,000K) sponsored by USAF Cambridge Research Center, L. G. Hanscom Field, Bedford, Mass.

Mar. 18-19—First Inter-Service and Industry Symposium on Guided Missiles Training Equipment (limited to those with Secret clearance), Naval Ordnance Laboratory, White Oaks, Silver Springs, Md. For details write Mr. J. G. Vaeth, Head of New Weapons & Systems Division, U. S. Naval Training Device Center, Port Washington, N. Y.

Mar. 24-27—Institute of Radio Engineers National Convention, Waldorf-Astoria Hotel and New York Coliseum, New York City.

Mar. 24-29—Fourth International Instrument Show, Caxton Hall, London.

Mar. 30-Apr. 1—RFC RNAS Reunion (World War I), Toronto, Canada. Contact: C. B. Stenning, Chairman, 149 South Drive, Toronto 5.

Mar. 31-April 4—American Management Assn., Management Methods for Professional People Seminar, Sheraton-Astor Hotel, New York City.

Apr. 8-10—Eighth International Symposia, Electronic Waveguides, Engineering Societies Bldg., 29 W. 39 St., New York City.

Apr. 10-11—Aeronautical Training Society, Annual Meeting, Mayflower Hotel, Washington, D. C.

Apr. 10-12—Southwestern Institute of Radio Engineers Conference and Electronic Show, St. Anthony Hotel and Municipal Auditorium, San Antonio, Tex.

Apr. 16-19—14th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New Yorker Hotel, New York City.

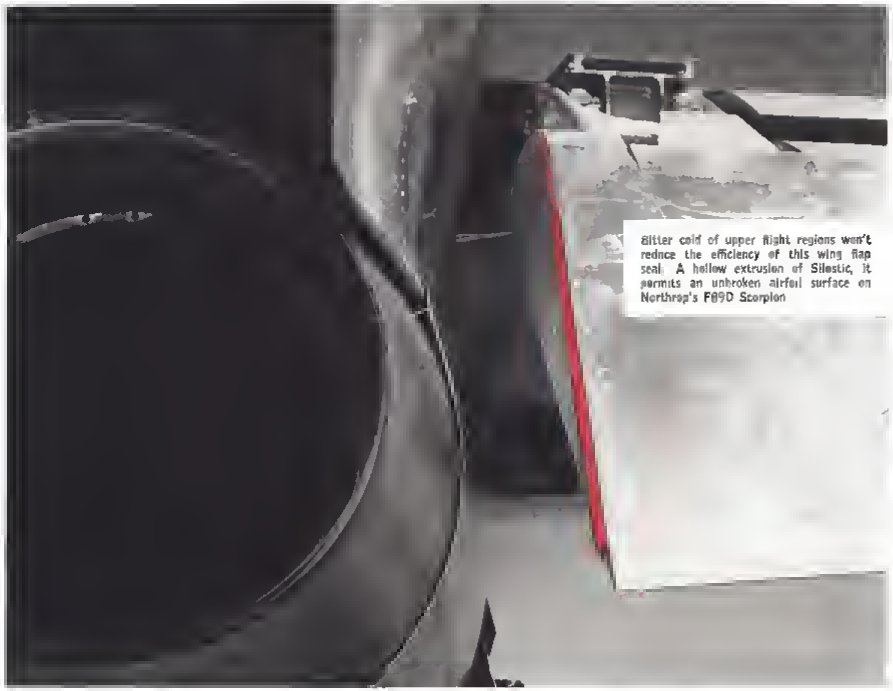
Apr. 22-24—1958 Electronic Components Conference, Ambassador Hotel, Los Angeles, Calif.

Apr. 28-30—Second Annual Astronautics Conference, sponsored by Air Force Office of Scientific Research and Institute of Aeronautical Sciences, Shirley-Savoy Hotel, Denver, Colo.

May 4-7—Fourth National Flight Test Instrumentation Symposium, Park Sheraton Hotel, New York City.

May 12-14—National Conference on Aeronautical Electronics, sponsored by Institute of Radio Engineers, Biltmore Hotel, Dayton, Ohio.

May 14-16—Spring Meeting, Society for Experimental Stress Analysis, Hotel Manger, Cleveland, Ohio.



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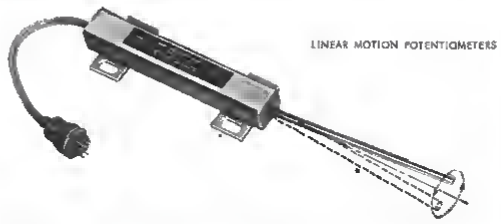

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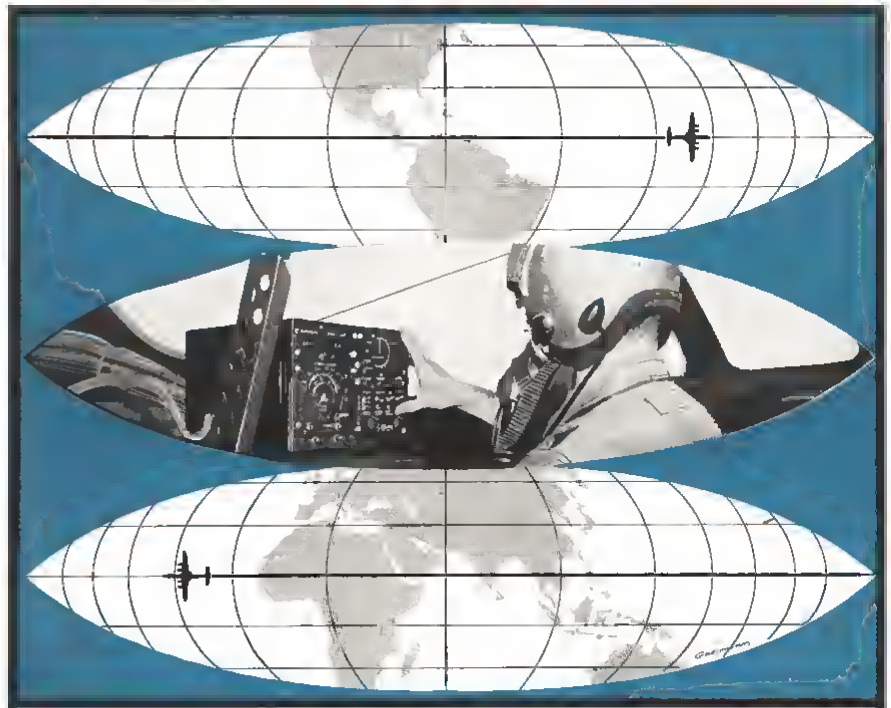

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- Oil Cooler Door Hinges
- Cowl and Hinges
- Flap Hinges

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- Radar: Ignition Tubes, Amplifiers, Height Finders, Entire Systems
- Radio: RDF/1A Units, Receivers
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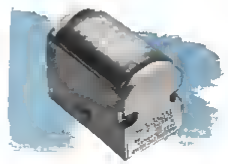

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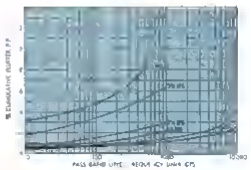

Cumulative flutter at 1⅞ and 3¾ ips is approximately one-half that found in other tape equipment. CEC is first to achieve the low-speed flutter characteristics shown at left. Chart shows flutter recorded at 30 ips and played back at speeds indicated.

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February 10, 1958

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COVER: Lockheed F-104 Starfighters are shown on the final assembly line at Palmdale, Calif. F-104's thin, relatively light wings are bolted to fuselage intake ducts by simple flanged fittings. Fuselage rings in this area become the wing carry-through structure to save critical fuselage space. Horizontal tail is similar to wing in configuration and thickness; single-piece skin gives maximum strength and stiffness. F-104As will soon become operational with Air Defense Command at Hamilton AFB, near San Francisco. For story and other photos on F-104 see p. 66.

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EDITORIAL

The Race for Space

Success of the Army's Explorer satellite offers further proof, if at this late date any more is needed, of the fundamental fallacies that have artificially retarded the U S. effort in the race for space. These are

- **Failure to recognize** the military implication of space exploration and technology
- **Divorcing the satellite program** from the existing military missile effort and creating an artificial gulf between "science" and "military" efforts to explore the unknown
- **Holding back the technical ability** and capabilities of U S science and industry by top-level governmental committee indecisions

The Army's Explorer was successful on its first shot because it utilized well developed components of the Jupiter-C research missile and was operated by an established technical team well seasoned in the missile business Great credit is due to the technical team of the Army's Redstone Arsenal, California Institute of Technology's Jet Propulsion Laboratory and the University of Iowa group headed by Dr James van Allen who combined to conceive and operate Explorer successfully The propulsion did not falter through four stages of operation because it utilized well proven systems, including the North American Rocketdyne liquid fueled Redstone rocket and the solid fuel, scaled down Thiokol Sergeants built by Jet Propulsion Laboratory Guidance depended again on well developed hardware built by the Ford Instrument Co.

Policy of Indecision

However, despite the lessons underlined by the Explorer's success and the continued troubles of the administratively tangled and technically over-sophisticated Vanguard program, there is no indication of any fundamental change at the top leadership level of the government in pressing on to overtake and surpass our Soviet competitors in the race for the useful employment of space With the exception of the Jupiter C program, unleashed by Defense Secretary Neil McElroy following Sputnik I after it had been administratively squashed for two years, there has literally been no genuine or decisive action on the multitude of specific proposals for scientific and militarily useful exploration of space

Once again, the technical brains of science, the fabricating skills of industry and the bold, forward reaching concepts of some military leaders are being suffocated by the multi-layered blankets of top level governmental bureaucracy

We now face the process of a prolonged congressional debate over who shall operate the space program, an impending possible battle between Congress and the executive branch of the government over how the job should be done, and the strong possibility of at least two new agencies being organized to start afresh with the space problem—Advanced Research Projects Agency in the Pentagon and a new National Space Agency While this political hassling transpires, virtually every technical proposal for accomplishing something NOW and beginning the step-by-step exploration of outer space is gathering dust in some government office, most of them in the Pentagon

Needed Channels Exist

The tragedy of this situation is that channels to get this program moving already exist (AW Feb 3, p 21) and need only an affirmative decision from the top levels of our government to start the technical process flowing at a maximum rate

Many of the practical steps that could be taken with existing missile hardware NOW are detailed in a report by AVIATION WEEK's military editor Evert Clark on page 26 of this issue All of these proposals have been in the Pentagon for months None of them would be implemented until the new space bureaucracy is created and begins operating in the Advanced Research Projects Agency Not only are none of the new programs proposed being implemented but the existing space research programs, many of which have been making sound and steady progress for as much as five years, are being slowed to a walk pending the high level decisions on who is going to run the program and take the kudos for whatever the working level scientists, engineers and military research people have done in laying a sound foundation for future space exploration

It is indeed a sickening spectacle to see a nation that is teeming with scientific and industrial resources and with no lack of sound military development concepts again being hamstrung in utilizing this full capability by a lack of top-level political leadership and an abysmal absence of the executive ability required to unleash this capacity for maximum results

Technical Timidity

When the history of the international race for space is written we predict that the historians will find that it was not lack of technical brains and industrial ability that got the U S into space behind the Soviet Union and horribly hobbled its effort to overtake and surpass its competition. Rather, the fault will be credited to technically timid "leadership," lack of clear-cut national goals and priority to achieve them, to a cumbersome bureaucracy that dissolved the decision-making process and to a political battle for power

Despite the fine success of the Army's Explorer, the U S technical drive into space is at a virtual standstill while it awaits the outcome of the great political debate over who will run the space program and how.

—Robert Hotz

WHO'S WHERE

In the Front Office

Vincent J. Roddy, president, American Screw Co., Willimantic Conn

George A. Kendall, divisional president and general manager, Machine Tool Division, Wickes Corp , Saginaw, Mich.

J A Reid, executive vice president and general manager, and **T. E Myers**, vice president and assistant general manager Astrodyne, Inc , (Air Force Plant 66) McGregor, Tex

Maj Gen Albert Boyd (USAF, ret), vice president Westinghouse Electric Corp , Pittsburgh, Pa and general manager of the Defense Products Divisions

Richard T. Holt, vice president-aircraft and missile sales The Fenn Manufacturing Co Newington Conn

Robert H Dasley, vice president planning Eaton Manufacturing Co , Cleveland Ohio **William A Mattie** succeeds Mr Dasley as vice president administrative

William C. McDonald, vice president engineering and manufacturing, Non Linear Systems Inc , Del Mar Calif

J H Dalton, assistant to the president Servo Corporation of America, New Hyde Park N Y

Aden B Meinel, director of the new National Astronomical Observatory (to be located in the southwestern area), National Science Foundation, Washington, D C

Honors and Elections

Navy Distinguished Public Service Awards, the highest honor the Secretary of the Navy can bestow upon civilians have been presented to the Director and four staff members of The Johns Hopkins University Applied Physics Laboratory for their contributions and services in the development of the Terrier guided missile The recipients **Dr. Ralph E Gibson**, Director of the Laboratory, **Dr Alexander Kossiakoff**, **Henry H Porter**, **Dr Richard B Kershner Robert C Morton**

Wilfred Dukes, chief of the structural analysis section for the Special Weapons Division of Bell Aircraft Corp , has been named chairman of a panel formed by the Materials Advisory Board of the National Academy of Sciences National Research Council, Washington, D C The panel will conduct a study in the field of thermal protection systems in airframe designs

Changes

James O Urquhart, general passenger service manager Northeast Airlines Inc Also **M Wilson Offutt, III**, general sales manager, and **Maurice M. DeGroff**, general traffic manager

Herbert E Ryker, assistant to the executive vice president, Ryan Aeronautical Co San Diego, Calif

Charles S Roberts, Jr., chief project manager, Utah Division, Thiokol Chemical Corp Brigham City, Utah

Robert Hodges, manager Airborne Systems Division, G M Giannini & Co., Inc , Santa Ana, Calif

(Continued on p 109)

INDUSTRY OBSERVER

► Primary limitation on what Army can do in the missile field is now one of weight rather than range Major emphasis in Defense Secretary Neil McElroy's new order removing Army's previous 200-mile-range limit, is on mobility Solid propellant Pershing—scheduled to have a range of approximately 500 miles—and its successors must be small enough to be airlifted and "easily" carried by Army trucks Under the McElroy order, Army can extend range of Pershing through advances in the state of the art (AW Feb 3, p. 25)

► **Fairchild's four-propeller VTOL design (AW Jan. 27, p. 37) is powered by a single General Electric T58 turboshaft engine. Army has provided two engines to Fairchild to conduct test program.**

► McDonnell Aircraft Corp 's entry in USAF's jet utility transport competition resembles a miniature Boeing 707. Its designation is Model 119 Aircraft, with a 10-seat capacity, mounts four individually-podded engines, two slung on pylons under each swept wing Powerplants being considered are the Fairchild J83 and General Electric J85 North American Sabreliner four-passenger jet and Lockheed's 10-passenger Jetstar jet both mount the engines on the aft fuselage behind the wing

► **U S price for the Fairey Rotodyne will be in the neighborhood of $1 2 million U. S. Army and Navy officials have seen the turbine-powered VTOL transport, and Fairey is making a quiet investigation of U S distribution and sales possibilities One unusual design feature of the aircraft is that the twin canted fin sections mounted on top of the stabilizer can act as fins in the canted position or be folded to the horizontal to act as stabilizers**

► Piasecki, under a recent technical agreement with Breguet, will attempt to interest the Pentagon in the French firm's 21 passenger STOL aircraft, the 940 Integral The Integral, powered by four Turbomeca turboprop engines rated at 400 eshp , is scheduled to make its first flight this spring At a gross weight of 14,300 lb , takeoff distance is scheduled to be about 200 ft Breguet is planning a larger version, the 941 which will be twice the size of the 940, powered by four 1,000 eshp turboprop engines, probably General Electric T58s

► **Chance Vought Regulus II long-range airbreathing missile will be deployed on Navy's new nuclear-powered missile cruiser, the U S S Long Beach, whose keel was laid on Dec 2 at Bethlehem Steel's Quincy, Mass , shipyard**

► Sud Aviation's Caravelle jet transport is now undergoing cold weather utilization tests in Sweden Both ground and flight tests are being conducted Last year, the Caravelle was put through a series of equator temperature tests in the French Sahara

► **Soviet Defense Ministry says one Russian fighter now in quantity production and in operational use "frequently" reaches an altitude of over 62,000 ft Aircraft is probably the MiG-21.**

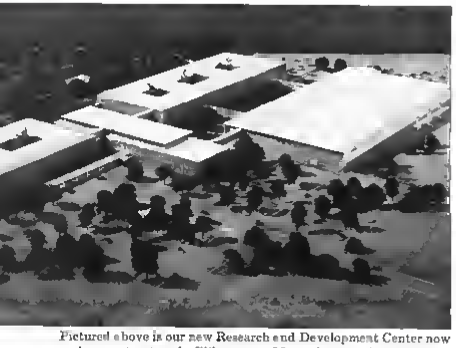
► Army's original request for Fiscal 1959 research and development funds was $584 million Figure was trimmed by over $100 million, to $471 million, as the proposal passed through Defense Department and Budget Bureau channels

► **Fiat G. 91 light fighter is the latest European military aircraft to be considered as a carrier for the de Havilland Firestreak infrared homing missile Three of the missiles would be carried by the fighter, one under each outboard wing and one under the fuselage. Project is under serious study, but no firings or flight tests have yet been made**

► Thor intermediate range ballistic missile firings totaled 11 as of early last week Five of the last seven have been successful

► **Total of 11 ICBM and IRBM launch pads are scheduled to be built at USAF's Cape Canaveral, Fla , launching site.**

J. W. Marchetti, Director, Avco Electronics Research Laboratory



Pictured above is our new Research and Development Center now under construction in Wilmington, Massachusetts. Scheduled for completion in early 1958, this ultramodern laboratory will house the scientific and technical staff of the Avco Research and Advanced Development Division.

Avco's new research division now offers unusual and exciting career opportunities for exceptionally qualified and forward-looking scientists and engineers in such fields as:

Science:
Aerodynamics · Electronics · Mathematics · Metallurgy
Physical Chemistry · Physics · Thermodynamics

Engineering:
Aeronautical · Applied Mechanics · Chemical · Electrical
Heat Transfer · Mechanical · Reliability · Flight Test

Write to Dr. R. W. Johnston, Scientific and Technical Relations, Avco Research and Advanced Development Division, 20 South Union Street, Lawrence, Massachusetts.

CREATIVITY

If there is a single word that can best describe the aim and purpose of AVCO's Research and Advanced Development Division, it is creativity. We at AVCO have assembled those elements and that atmosphere which we believe are most conducive to true creative effort.

Our future progress depends on an early recognition of the difference between an *important* new idea and just a new idea. It is mere quibbling with words whether we call these things new discoveries, breakthroughs, or basic research. They are, in fact, merely the signposts of our future. The world in 1980 and the year 2000 will, in its technological aspects, be vastly different from what we know today. Yet locked somewhere on our present scientific frontiers is the knowledge that will spell out this difference. It is our purpose to help in the unlocking of that knowledge and to contribute our part to the over-all progress.

The most important ingredients of creativity are curiosity and a real will to work hard. Of only slightly lesser importance is the feedback, or close working relationship between theoretician and observing experimentalist. We at AVCO also realize that a single creative effort is the output of a man, or, at the most, of a small group of men at any one time. It is, therefore, continuously subject to the criticism of other men and some even more stultifying forces. Some of these are economic or organizational and others are of a more subtle variety. We of the AVCO management consider it our responsibility to be alert to both positive and negative factors affecting creativity. We consider the ability of our men to create for the future, the most important function of the AVCO Research and Advanced Development Division.

J. W. Marchetti,
Director, Avco Electronics Research Laboratory

AVCO
Research & Advanced Development

Washington Roundup

Army Anti-Missile Boast

Army has an excellent chance to become the operational service for the Nike-Zeus anti-missile missile and to receive additional development funds.

Rep. Carl Vinson (D-Ga.), chairman of the powerful House Armed Services Committee, has written to Defense Secretary Neil H. McElroy telling him that operational responsibility "should be promptly assigned" to Army.

Vinson's reasoning is that a service develops a weapon in accordance with its own doctrines of deployment and use, and Army development would "create situations which are quite incompatible with Air Force doctrine on deployment and use, should the Air Force subsequently be assigned operational responsibility."

Vinson also said he believes another $136 million must be made available to Army "at the earliest practical date" to accelerate the Nike-Zeus program, even though "this involves a calculated risk and I realize that we cannot proceed on the development of every weapon system on the same basis."

Letter was written in the name of the committee over the objection of Rep. James Van Zandt (R-Pa.), a committee member who told Vinson: "I don't think you have all the information."

Letter also was written before Explorer launching and Vinson's announcement that he will seek more support for Army programs (see page 38)

Twining vs. White

USAF Chief of Staff Gen. Thomas D. White and Gen. Nathan Twining, chairman of the Joint Chiefs of Staff and former Air Force Chief, have confounded senators with conflicting testimony as to whether additional B-52 production funding is needed now—or can be put off until later.

Gen. White testified that if the production is not funded by July 1, the B-52 production lines will be forced to close, not "only in Seattle, but in Wichita." USAF Vice Chief of Staff Gen. Curtis LeMay gave the same testimony. Gen. Twining, however testified that a decision will not have to be made on the funding until November.

Gen. Twining was supporting the position of Secretary of Defense Neil McElroy and Deputy Secretary of Defense Donald Quarles.

At a committee session, Sen. Lyndon Johnson (D-Tex.) commented:

"When generals give divergent opinions it is somewhat confusing. . . . We do not know which general to follow."

There are no B-52 production funds provided in the Fiscal 1959 budget. This means that if the decision is put off until November, a special money request will have to be made.

Congress may not be in session.

Submarine Missile Threat

Threat of ballistic missiles fired from submarines is one of the most serious the U.S. faces, Air Force Secretary James H. Douglas told the Senate Armed Services Military Construction Subcommittee. In testimony before the subcommittee on the supplemental military construction authorizations, released last week, Douglas said that, so far as he knew, the U.S. has no detection system that could warn of missiles fired from enemy submarines.

He said that assuming missile would have a range of less than a thousand miles, the warning period would be so short that it presents more difficult problems than any of the other methods of attack. He said he thought the principal program against that threat was the Navy's mission to destroy the submarines.

Transpacific Tangle

Battle-worn Transpacific Renewal Case is still not resolved despite President Eisenhower's approval last week of a Civil Aeronautics Board order denying Pan American-World Airways's application to serve Portland and Seattle on its Great Circle route to the Orient. Three times previously, the Board has ruled against Pan American on Portland-Seattle traffic rights and twice the President has returned the decision back to the Board for review.

This time the President, after a delay of several weeks, approved the Board action but left the door wide open for still more review.

His instructions to the Board for a report no later than Feb. 1, 1959, on the status of traffic growth between the U.S. and the Orient could reopen the entire Transpacific case.

In his letter to the Board, the President said his objective is "[illegible] to provide competitive United States service on all international and overseas routes from all gateways" when traffic justifies it.

Soviet's Hardsell

Central Intelligence Agency Director Allen W. Dulles gives the Soviet Union credit for doing "the greatest advertising job ever done" with its Sputniks and ballistic missiles. He also concedes that CIA may have to do more advertising of its own.

"If in our government, intelligence estimates have not always had the impact that in the light of hindsight they may have deserved, responsibility must be shared by the intelligence producer," Dulles said in one of his infrequent public addresses. "We have a chance to sell our wares."

Dulles also said "achievements do not depend so much on the type of government so long as the latter is technically competent and has a willing or subservient people at its beck and call.

"It depends on the goals and priorities set, the promptness and the correctness of the decisions reached, and the energy applied in terms of man hours with the proper tools and equipment."

Polaris Acceleration

Navy's plans to "super-accelerate" the nuclear submarine program for the Polaris fleet ballistic missile program have been finalized and may already have been submitted to the Department of Defense for approval. Navy Secretary Thomas G. Gates says the planned acceleration is based upon new tests and contemplates a crash effort. He estimated the acceleration, providing a total of nine Polaris submarines, would cost more than $1 billion.

—Washington staff

Indecision Blocks Prompt Moon Strike

Pentagon is swamped by proposals to send existing hardware to Moon; bottleneck is in high echelons.

By Evert Clark

Washington—Lack of decision is the only block to immediate attempts to explore the Moon. This delay will continue for some weeks, even though conquest of the Moon and control of the Earth from there are believed to be major national goals of the Soviet Union.

Specific hardware for unmanned exploration by the U.S., including airframes, propulsion units, guidance systems and instrumentation, exist now. Pentagon has been swamped with firm proposals for putting these to use (AW Jan. 20, p. 27). Some proposals predate the launching of Sputnik I.

But all space programs beyond the North American X-15 and earth satellites now are being delayed by lack of administrative approval at Defense Department and White House levels.

There is still debate as to whether the Moon or space platforms will be most useful for military operations. Center of the debate is which base might be established and exploited more rapidly.

But specialists who have studied the problem agree on one point—that the U.S. cannot afford to let Soviet Russia establish this type of operation first.

Why the Delay?

In spite of this conviction, shared by a great number of scientists and military men, proposals apparently will not be translated into action until authority and organizational responsibility for making decisions are neatly honed out (see page 37).

Cost and time estimates for putting a man on the Moon and establishing a military-scientific base there vary widely. One authoritative estimate is 10 years and $1 billion for the first step, and 20 years and $20-$50 billion for an operational base.

Initial steps of circling the Moon with instrumented rockets and landing extremely valuable instrument payloads on its surface are within present capabilities.

Major proposals submitted to Air Force so far include those of Martin Co., Convair Division of General Dynamics Corp., and North American Aviation Inc. Details of the proposals are still secret but some of their highlights are not.

Martin Co. Vice President H. W. Merrill, general manager of the Denver Division, believes that "tomorrow, the nation that controls the Moon will control the Earth." Martin's pre-Sputnik proposal would put the U.S. on the Moon ahead of anyone else, and a majority of its steps could be accomplished with the Titan intercontinental ballistic missile with no major change in design, Merrill said.

Martin Proposal

Highlights of the Martin proposal:

- **Titan in its present configuration** minus warhead can launch an earth satellite weighing more than 2,000 lb.
- **Titan also "could place a manned** satellite in orbit and, with current knowledge, return it safely to earth at will," Merrill said—still using its present configuration.
- **Titan with stages added** can accomplish reconnaissance flights around the Moon, using the same Aerojet-General Corp. engines now in production for the Titan missile.
- **Guidance system now in the Titan** would be "sufficiently accurate to hit a target much smaller than the size of the Moon," Merrill said. Arma Division of American Bosch Arma Corp. is inertial guidance contractor and Bell Telephone Laboratories Inc., is radio inertial guidance contractor for Titan.
- **Titan also "has a considerable design** growth factor applicable to the hardware requirements for probing space and reaching the Moon," Merrill said.

Convair Astronautics Division's proposal, also prepared before Sputnik I, would use its Atlas intercontinental ballistic missile booster and other existing hardware to:

- **Put USAF's WS-117-L** reconnaissance satellite into orbit around the Earth. This program is the only one beyond scientific satellites and the X-15 that is going ahead. It is under USAF supervision but will move under control of Advanced Research Projects Agency in Fiscal 1959. Target date now is believed to be early spring of next year.
- **Put payloads well in excess of 1,000** lb. in orbit around the Moon, Venus and Mars.
- **Land a payload of less than 1,000 lb** on the Moon.
- **Put a still smaller payload** between Mercury and the Sun.
- **Put other satellites,** including later manned versions of the WS-117-L and rings of surveillance communications satellites into orbit.

North American's Rocketdyne Division, developer and manufacturer of the rocket engines powering the Atlas, Jupiter, Thor and Redstone, and developer of the 400,000 lb. thrust Navaho booster engine cluster, obviously is involved in a number of proposals with other contractors. But combinations of the company's airframe, missile and rocket engine divisions are believed to have proposals that are strictly North American's.

Navaho booster is the largest thrust engine in the free world, and use of improved fuels could increase its thrust. This booster plus other existing stages might put 1,000 lb. of payload into orbit.

Nuclear Engines

Rocketdyne also has been working for more than a year on nuclear engines. Basic Redstone engine now has a claimed reliability of 99%.

North American also would like to use Navaho boosters to make an orbital manned aircraft of the rocket-powered X-15. So far, three copies of X-15 have been ordered, none of them structurally designed for orbiting. Neither acceleration of the program, change in design of any of the three, nor construction of modified copies have been ordered.

Recognition of the importance of making at least exploratory passes at the Moon have been stated by a number of military and government officials, including USAF Secretary James H. Douglas.

Planning for such projects rests in USAF with the Directorate of Development under Lt. Gen. Donald Putt, but confusion over the role of the new Advanced Research Projects Agency and other proposals for control of space have kept any action from being taken.

Key man in USAF's astronautics proposals is Putt's deputy for research and development, Brig. Gen. Homer A. Boushey. Although Boushey points out that military opinion still is divided as to the significance of the Moon as a military base, he personally believes control of the Earth lies in controlling the Moon.

Boushey also believes Russia's own statements leave little doubt that she considers control of the Moon—not just its exploration—a primary goal.

Admitting that many complicated steps lie ahead, Gen. Boushey and others still see the Moon as a potential "high ground" in a future war involving Earth.

Some of its possible military advantages as Boushey sees them:

- **Relatively low gravity** might mean that warheads without rockets could be catapulted from shafts sunk deep into the Moon's surface, with enough energy to reach escape velocity.
- **Missiles launched earthward** could be observed and guided from start to impact. Reverse is not true, because the Earth's rotation necessitates multiple tracking and guidance stations, and weather could interfere.
- **Missile attack launched** from Earth to Moon could be observed from the Moon with perhaps 48 hours to take counteraction. Lack of atmosphere eliminates blast effect of nearby nuclear explosions. Long warning time would allow Moon personnel to compute lunar impact points and go underground to escape thermal, X-ray and neutron radiation.
- **Since missile speeds** for approach and lunar impact would be less than those for Earth impacts, anti-missile efforts would be easier from a Moon base.
- **Lunar outposts and even** launch sites could be located on the unseen side of the Moon, while Earth observation posts could be kept on the sunlit side. Resolution of objects less than 100 ft. in length—and with new techniques, perhaps 50 ft. in length—could be accomplished with moderate sized lenses, Boushey said.
- **Moon provides a retaliation** base of unequalled advantage. "If we had a base on the moon," Boushey said, "either the Soviets must launch an overwhelming nuclear attack towards the Moon from Russia two to two and one-half days prior to attacking the continental U.S. (and such launchings could not escape detection) or Russia could attack the continental U.S. first, only and inevitably to receive, from the Moon some 48 hours later, sure and massive destruction."

Unless international agreement to explore space only for peaceful purposes can be achieved, Boushey believes space flight must become an integral part of deterrent force—and "eventually space superiority will become the primary factor in the assurance of world peace."

Vast amount of exploration necessary to determine whether and how man could live on the Moon has only begun from Earth by means of telescopes, cameras, spectrographs, radio and radar probings and a lot of theorizing.

Moon's average distance from Earth is 238,857 mi. Its diameter is 2,158 mi., more than one-fourth that of the Earth although Earth has 81 times the mass of the Moon.

It takes exactly as long to circle the Earth as to rotate on its own axis, never showing but one face to the Earth. But a slight wobble allows observers here to see a total of 59% of its surface over a period of time.

Temperatures range as high as 214F and as low as 243F below zero in the top few inches of surface dust during the 15-day periods of sunlight, but measurements of radio energy indicate that the temperature is a constant 40F below zero only a few inches below the surface.

The Moon's surface is far rougher than that of the Earth, but radar soundings over the past few years by Naval Research Laboratory scientists indicate it still is much smoother than telescopic and earlier radar probings had established. These scientists also believe their work shows that generally accepted calculations of distance have been off by several hundred miles, or there is a large amount of material in space between Earth and Moon (AW Sept. 9, p. 44).

Nevertheless, mountains on the Moon rise to an estimated 31,000 ft. Ranges such as the Alps, Caucasus, and Apennines contain peaks ranging from heights of about 12,000 to 18,000 ft.

Since the Moon's gravity is one-sixth that of Earth and escape velocity is 1.5 mi. per second, little if any atmosphere remains to sustain man or to protect him from radiation, meteoric dust and meteorites. It is estimated that 1,000 tons of meteoric dust a day sifts down through the Earth's atmosphere.

Astronomers say heavy gases such as xenon and krypton might still be found, and some believe frozen water, methane or carbon dioxide could be found in the sunless crater bottoms and mountain shadows.

Although man has studied the Moon longer and harder than any other celestial body, there still is disagreement on such points as its origin and formation, creation of its vast craters, and the depth and make-up of its dust cover.

Most estimates of the depth of this layer of dust are in inches or feet but one theory estimates it in miles.

Crater formation now is generally believed to be the result of explosions caused by the bombardment of meteors ranging from dust particles to chunks of rock as much as a mile in diameter striking with a speed that released energy thousands of times that of a hydrogen bomb.

Moon Rocket

Washington—Authoritative Air Force sources stated flatly last week that it is possible to send a basic payload to the Moon this year using existing technology and hardware. This project, as reported by Aviation Week on Jan. 20 (p. 26), would use the first-stage Thor rocket motor and existing second and third stage rockets to land a package on the Moon containing a radio transmitter capable of transmitting data back to Earth and a spotter charge to visually mark the impact area.

De Havilland to Build T58

London—First postwar agreement under which an American aircraft engine will be built in Britain has been signed by General Electric Co. and de Havilland Engine Co.

De Havilland will build the 1,000 hp. T58 engine, developed by General Electric as the de Havilland Gnome, intended for use in British helicopters.

The British firm also plans to develop a turboprop version of the turboshaft and it may market this in the United States. There is at present no turboprop version of the T58.

The General Electric engine which, with its gearbox, weighs only 325 lb., has been described as the most powerful turboshaft engine in the world for its weight and size.

Under terms of the licensing agreement with General Electric, de Havilland will be free to sell the Gnome in export markets in "friendly" competition with the T58.

De Havilland plans to put the engine into production as rapidly as possible, with the first production engine scheduled to appear in 1959. Tooling up will begin immediately at the de Havilland Leavesden plant while engineers at the company's Stag Lane Division will undertake a modification program to adapt the engine to British requirements. This will involve, among other things, changes in the gearbox to accommodate different rotor speeds.

Most likely candidate for the T58 engine is the Westland version of the Sikorsky S-58 helicopter. Negotiations with the Ministry of Supply for such an order are underway.

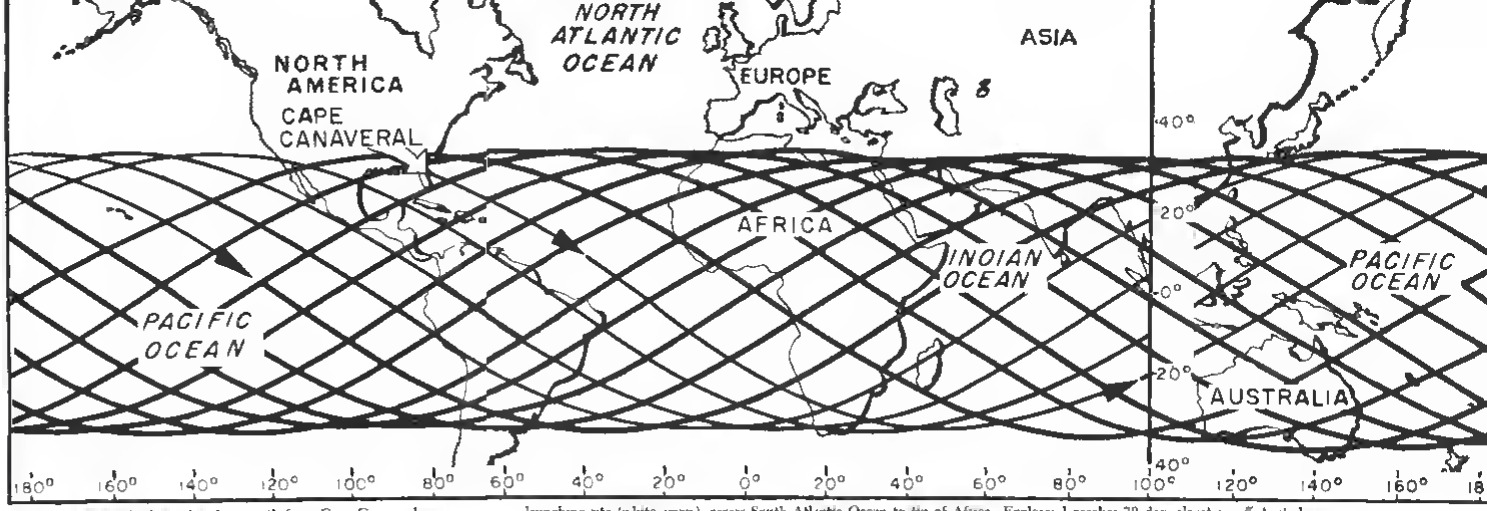
With Britain's second-generation helicopters all likely to be turbine-powered, de Havilland expects to exploit the field actively with the Gnome engine. Bristol helicopters would be another likely customer.

Under the agreement, de Havilland also will build in Britain, in the future, more powerful versions and variants of the T58. The British company does not plan to undertake turboprop development of the engine until turboshaft production is well underway.

De Havilland believes there is a good export market for both the turboshaft and turboprop versions.

The agreement is an outgrowth of an interchange of technical information between the two companies which has been in operation since 1951.

The T58 passed its United States type test in October last year.



EARTH satellite's 360 deg. orbit shows path from Cape Canaveral launching site (white arrow), across South Atlantic Ocean to tip of Africa. Explorer I reaches 20 deg. elevation off Australia.

Army Launches Satellite, Bids for Space; Vanguard Fails

SEARCHLIGHTS illuminate Jupiter-C at initial firing time (left), detailing bucket-like second and third stages and Explorer I Earth satellite mounted as part of fourth stage. Spin launcher is mounted on Redstone nose (pictures on p. 61). Above, first stage blast pushes Explorer I higher.

Washington—Army last week moved rapidly to exploit its successful launching of the first U.S. satellite by requesting Defense Department approval of plans to put two television reconnaissance vehicles, weighing 300 and 700 lb. respectively, into orbit before the end of the year. Army also is scheduled to launch another small satellite, similar to the 30.8 lb. Explorer I, within 60 days.

Four days after the Explorer launch, Navy's second attempt to place a 6-in. test satellite into orbit ended in failure a minute after an apparently successful launching of the Vanguard rocket. Subsequent analysis of telemetered data revealed malfunction of first-stage engine control system which suddenly deflected rocket engine to the right, producing abnormally high forces that broke Vanguard in half. Rocket was then intentionally destructed by range safety officer. Navy hopes to recover sufficient parts to make a more detailed analysis.

Proposed Army reconnaissance vehicles, similar in purpose to the Air Force Lockheed Pied Piper Project (AW Oct. 14, p. 26), would be equipped with one or two miniature television cameras whose output would be stored on small tape recorders until the satellite came within range of a ground station. Recorded signal would then be transmitted to the ground at extremely high speed, stored there, later played back at normal viewing speeds.

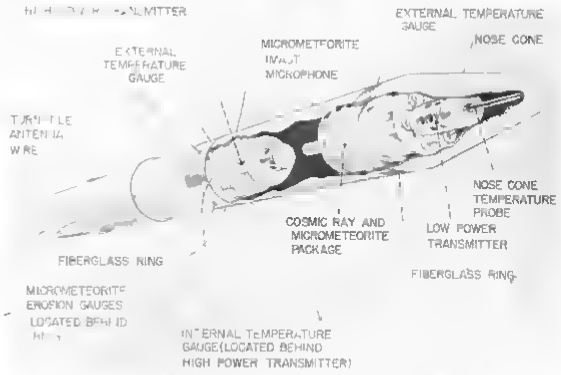
Radio Corp. of America has developed a miniaturized, transistorized television reconnaissance camera whose low power consumption makes it ideal for the Army vehicle. RCA also has developed a new infrared TV camera, sensitive out to infrared wavelengths of 10 microns which should also prove useful for a reconnaissance vehicle.

Army's next satellite, Explorer II, will carry a small tape recorder which will be used to evaluate problems involved in storage of data and rapid transmission when the satellite nears a ground station.

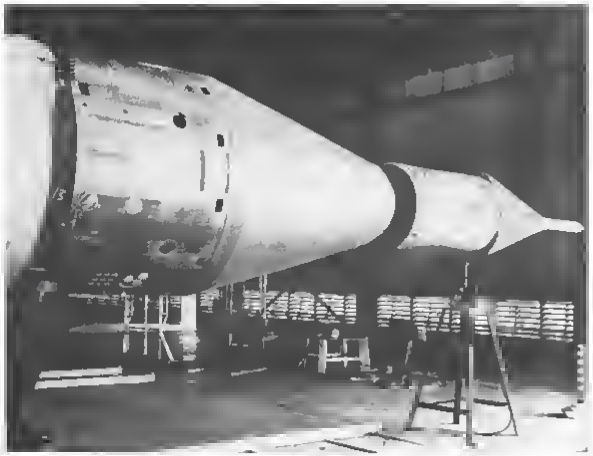
To place its proposed heavy satellites in orbit, Army may use extra-power version of its Redstone missile, whose 83,000 lb. thrust placed Explorer I in orbit. Additional thrust for subsequent stages could be obtained by adding a stage and/or more rockets per stage.

There also is some thought of using "Super Jupiters," presumably a modified version of Army's intermediate range ballistic missile with thrusts reportedly 2½ to 4 times greater.

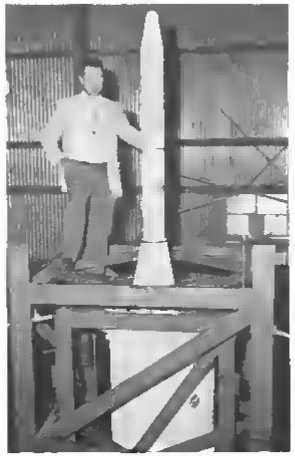
Although Explorer I weighs only one-sixth as much as the Russian Sputnik I, and about only one-fortieth that



EXPLORER I instrumentation includes nose cone temperature probe. Fanning out from midsection are antennas with weighted balls on ends of rods.



SPIN launcher assembly of Earth satellite is joined to nose section of main stage rocket in engineering shop. Rocket was modified after re entry tests



FINAL assembly is placed on "balancing tub" at development test laboratory

of Sputnik II, the four-stage Jupiter-C succeeded in thrusting the U S satellite considerably farther out into space.

Recent orbit computations by Naval Research Laboratory indicate that the U S satellite now has an apogee (high point) of about 1,600 mi., almost three times the figure for Sputnik I and 50% greater than that of Sputnik II. Satellite perigee, which determines its lifetime is calculated at 220 mi., nearly twice the figure for Sputnik I and 50% greater than Sputnik II.

On the basis of preliminary orbit calculations, some scientists are predicting a lifetime of 2 to 12 years for Explorer I. Sputnik I lasted for about three months. Sputnik II has just completed its third month.

Early reports from Explorer's radio transmitters—telemetering data on cosmic ray intensity, micro meteorite density and satellite temperature—are encouraging, according to officials of California Institute of Technology's Jet Propulsion Laboratory which is analyzing the data. JPL also assembled the upper stages and provided the satellite transmitters.

Explorer I Highlights

- **Size**: Six inches in diameter, 80 inches long, including fourth stage rocket case.
- **Weight**: 30.8 lb.
- **Payload**: 18.13 lb.—radio transmitters, instruments.
- **Apogee**: Approximately 1,600 mi. (Russian Sputnik I: 580 mi., Sputnik II: 1,056 mi.)
- **Perigee**: Approximately 220 mi. (Sputnik I: 130 mi., Sputnik II: 143 mi.)

Instrumentation includes:

- Cosmic rate count.
- Temperatures of satellite skin—fore and aft—the interior and nose cone.
- Micro-meteorite density, distribution and relative momentum. Information is telemetered to ground stations by means of two satellite transmitters. One, operating at 108.00 mc., which also serves for tracking satellite, is expected to operate for two or three months on batteries, puts out 10 milliwatts power. Higher power transmitter (60 mw.), is expected to operate for about two or three weeks before batteries give out.
- **Launching vehicle**: Four-stage Jupiter-C., overall length 70 ft., weight, 64,000 lb.
- **First stage**: Redstone missile, modified to burn hydrazine-based compound instead of alcohol, boosting thrust 12% over conventional Redstone engine. Powerplant by North American Rocketdyne.
- **Second, third, fourth stages**: Cluster of 11 solid propellant rockets, surrounding cluster of three or four rockets, surrounding single rocket final stage. Multi-stage cluster is rotated at approximately 560 rpm. about 11 minutes prior to launch, increased to 750 rpm. at launch to provide gyroscopic stabilization and prevent thrust unbalance in event one of the rockets fails to fire.

This is the launch sequence:

- First stage burned for approximately 160 sec., by which time Explorer had reached speed of 6,800 mph., altitude of 53 mi.
- After first stage dropoff, the vehicle coasted, arching over until it reached altitude at 200,220 mi., roughly 400 seconds after launch.
- Second stage rockets were then ignited by radio control. After burn-out second stage was detached and third stage automatically fired, followed by the fourth stage whose speed reached 18,000 mph., placing Explorer I in orbit.

■ **Cosmic ray intensity** appears to be only about 12 times greater at Explorer altitudes than on Earth.

■ **External temperature** of satellite skin, resulting from periodic exposure to solar radiation, varies over a range of minus 100 to plus 300 degrees centigrade. However, insulating technique developed by Jet Propulsion Laboratory, using stripes of aluminum oxide coating about a quarter of an inch thick around the nose cone and instrument section, reduces internal satellite temperature variation to 0 to 30 degrees centigrade.

● **Micro-meteorite particle density** does not appear severe. Three of 12 wires that form grid used to measure abrasive effect of micro-meteorite particles are damaged, but this was detected during the initial orbit and scientists suspect damage occurred during launching.

Army satellite launching produced space data from an unexpected source, at least indirectly, but it added nothing in the way of new knowledge. Within hours after Explorer I was in orbit, Russians called International Geophysical Year headquarters in Brussels, Belgium, to say that preliminary results of its own satellite programs were "in the mail." The U S S R report, when received, failed to disclose any new information on Soviet satellite program, such as intensity of solar radiation, X rays and ultraviolet, according to IGY Secretary General Marcel Nicolet.

Ten of 11 planned Minitrack stations are now tracking Explorer I to firmly establish its orbit and to receive telemetered data. Air Force AN/FPS-17 radars in Laredo, Tex., and in Turkey, are among the long range radars being used to spot the U S satellite. Stanford Research Institute radar for ionospheric research also is being employed.

Prestige of Army Ballistic Missile Agency, riding a crest following the successful launching of the first U S satellite, was further enhanced by the second failure of Navy's Vanguard. The achievement is expected to aid ABMA's chances of getting Defense Department approval to develop a rocket engine with a 1,000,000 lb. thrust.

Navy Vanguard scientists, openly dispirited over the most recent launch attempt, say a third vehicle is being readied for launching. However a minimum of four weeks probably will be required to run through static tests.

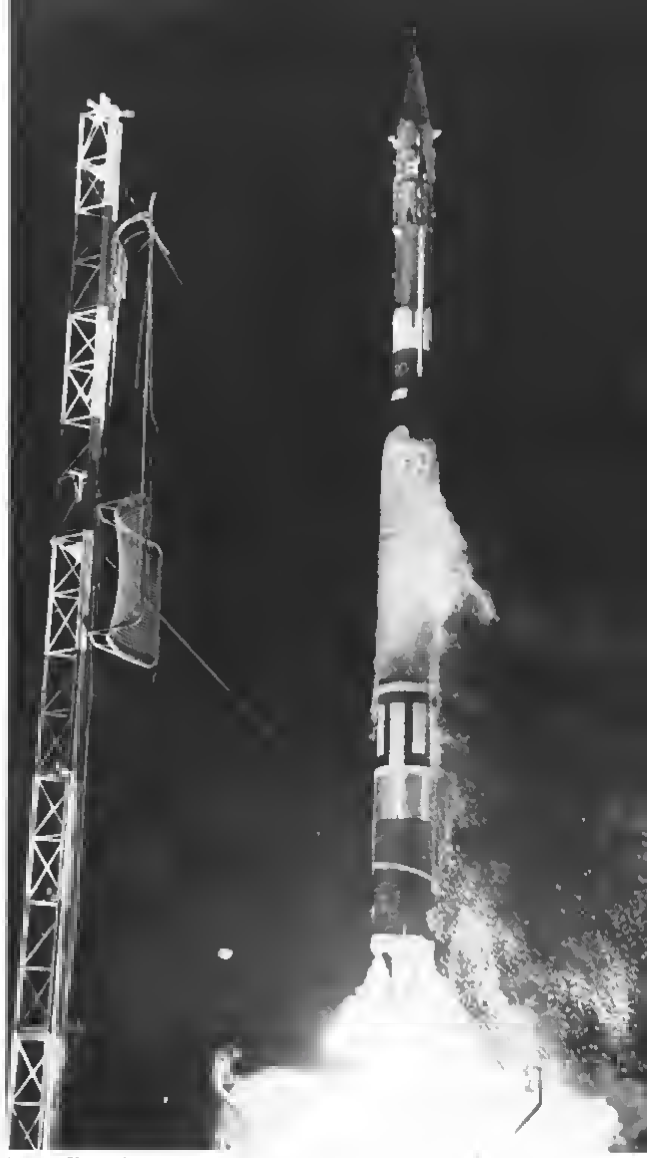
Soviet press and radio, which delayed more than 24 hours in reporting the successful launching of Explorer I, reported the unsuccessful launch of the second Vanguard vehicle less than an hour after the event.

Jupiter-C used to place Explorer I in orbit was developed jointly by the Army Ballistic Missile Agency and California Institute of Technology's Jet Propulsion Laboratory for research on the re-entry problem in development of Army Jupiter intermediate range ballistic missile.

The 70 ft.-long Jupiter C is two feet shorter than the Navy's three-stage Vanguard vehicle. However, the relatively stubby Jupiter-C weighs 64,000 lb., compared to Vanguard's 22,600 lb., develops 83,000 lb. initial thrust compared to Vanguard's 27,000 lb. Vanguard's liquid-propellant second stage develops approximately 7,500 lb. thrust.

Jupiter-C employs an inertial guidance and control system produced by Ford Instrument Co. and by ABMA. Vanguard uses an inertial guidance system produced by Minneapolis-Honeywell.

Almost lost in the welter of solid propellant rocket fuel developments, Rocketdyne's new high energy liquid fuel, Hydyne, could prove as significant



SECOND Vanguard test vehicle carrying a 6-in. satellite leaves the launching pad at Cape Canaveral, Fla. leaving a trail of ice breaking away from the center of the rocket where the liquid oxygen tanks are placed. Naval Research Laboratory said first 57 sec. of flight were normal with all components functioning normally. "Our telemetry records show that between the 57th and 60th sec. after takeoff small irregularities occurred in the first-stage engine control system," the Laboratory said. At that point a failure in the control system caused the gimbaled engine to deflect far to the right. For what happened next, turn page.

VANGUARD explodes after Feb. 5 launching at Cape Canaveral, with main section breaking up at upper right. Rocket control system failed in 60th sec. Parts which fell near Test Center will be studied.

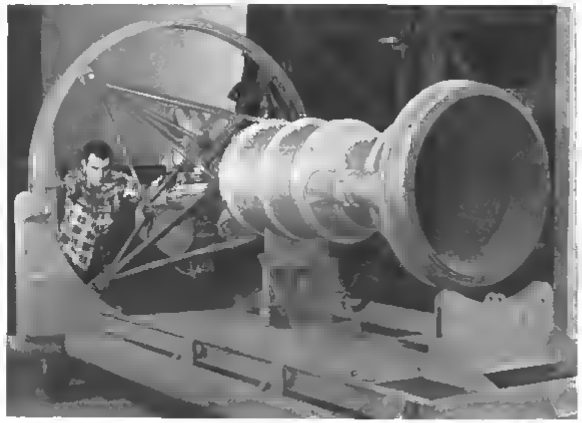
FLAMES mark path of first stage, visible at bottom. Some parts fell into Atlantic Ocean and may be recovered by divers.

a development as the satellite itself.

Based on Hydrazine, Hydyne is produced by "a unique blending of two commercially available chemicals that never before had been used at the high thrust levels of rocket engines." Used in place of alcohol in the first stage of the Jupiter-C, Hydyne boosted standard Redstone burning time and burnout velocity by 12%.

More important, the new fuel required no change in engine hardware or missile tankage. The physical properties of Hydyne, according to the company, are very close to those of the alcohol that it replaced. The implication here is that Hydyne can be substituted for alcohol in all other missiles using a liquid oxygen-alcohol system.

Work on Hydyne started in 1956 at Rocketdyne. The company continued development of the fuel and carried out a number of successful static test firings. After the development work was finished, Rocketdyne turned the new fuel over to commercial chemical companies for quantity production.



HYDYNE compound flows through hollow walls in this Redstone engine, cooling fuel. Note ridges and grooves in nozzle exit at right.

Germans Test First Postwar Helicopter

By David A. Anderton

Bremen—Germany's first postwar helicopter, designed by prewar pioneer Prof. Heinrich Focke, is completing its 100 hr. ground run and is expected to fly either later this month or early in March.

Focke's design is a single rotor conventional layout with three-place capacity— not crowded, but plenty of room, he said. Powerplant is a 260 hp. Lycoming VO-435A1A piston engine. Design cruise speed is about 100 mph.

The helicopter was designed from the start as a commercial project. No final price has been set, but Focke told AVIATION WEEK that a reasonable figure would be between $37,000 and $50,000.

Focke has a 23 man engineering team, financed and supported technically by the Bremen automobile manufacturer Dr. Carl Borgward. Project began in August, 1956, with Focke and one assistant doing studies; detailed design began two months later. Design is in complete agreement with U.S. CAA rotary-wing specifications adopted by German Transport Ministry as its standard.

Bridge 12-Year Gap

Unlike many other German aircraft design teams, members of the helicopter group here are current in their knowledge of the state of the art. They have bridged the 12 year gap that was so disastrous for other engineering organizations in this country's wartime aircraft industry. Focke explained that it was partly a question of being asked by one country or another to work there—"and we could hardly refuse— and partly a question of technical as well as physical survival that ensured the engineering continuity now visible in the Focke design.

Both Focke and Borgward are reluctant to say anything about the helicopter until it has flown successfully. Neither will they give any further details of the design. This is partially because of Defense Ministry security regulations and partly because both engineers are conservative. As one of them said: "We don't want to be like the American Sputnik attempt; we'll wait until we have accomplished something."

Focke's personal record of accomplishment is impressive. He is completing a quarter century of helicopter design work that began with the FW 61, a twin lateral rotor layout that created a major sensation when it was flown by veteran test pilot Hanna Reitsch inside the Berlin Sports Hall.

Focke himself had political problems during the war, though serving on the board of Focke-Wulf, which he helped organize, he was allowed no part in technical decisions. Eventually Focke asked to be allowed to resign from the board, his original investment was returned and with it he formed the Focke Achgelis Co. to concentrate on helicopters.

Focke's War Design

Biggest helicopter of the war was the Focke 223 design, a twin lateral rotor configuration with a single 1,000 hp. BMW radial engine. The helicopter was developed and flight tested, but did not get into quantity production nor did it reach service.

It did complete a series of tests which were staggering examples of performance, viewed now in hindsight. It lifted the complete forward section of a crashed Dornier twin engined bomber weighing more than 3,000 lb., off the ground where it hit. But it was a hot day and the performance was just marginal, so that the pilot was only able to move the load to a nearby road.

He later returned at night, when the temperature had dropped, to complete the salvage.

The war ended with Focke's factory in the French zone of occupation, and he was invited to go to work for Sud Ouest Aviation. Of the three remaining Focke 223 helicopters, one was deliberately destroyed by its pilot, one was sent to England and one to the United States.

In France, his team worked on the same helicopter, which eventually became the SE 3000. This work terminated in 1947.

Focke then had an offer to go to England and work for Percival Aircraft Ltd., in helicopter development. He was agreeable, but one year elapsed with no final decision, so both parties terminated the agreement. Focke received a year's salary anyway.

Next stop was Holland, where Focke saw a chance to finance his convertiplane ideas which by then had taken rather definite shape on his drawing board. He established a design office but the money ran out and the project was terminated in 1951.

Brazil Project

About that time the Brazilian government was organizing its technical center near Sao Paulo and invited Focke to come over there to continue his work. (AW Feb. 12, 1956, p. 336). A dozen of his collaborators and Focke went to Brazil and continued the development of the convertiplane—a tilting rotor type—which now is about ready for its ground runs. The team also built a two place conventional helicopter powered by a 225 hp. Continental engine.

The warm Brazilian weather proved disagreeable to Focke, and he returned to Germany and a professorship at the Technische Hochschule at Stuttgart. During summer vacations he goes to Brazil and serves as consultant.

His association with Borgward began

New 'Volks'-Copter Storts Tests

Compact helicopter designed by former Messerschmitt engineer Bade Franke is designed to carry three persons at a cruise speed of approximately 100 mph. A 105 hp. rear-mounted engine powers two blade coaxial rotors. Franke estimates that his 'Volks'-Copter would sell for approximately $15,475 if produced in quantity.

when he did some lightweight body shell designs for the Auto Mobile Co, using aircraft techniques. One of these designs was built.

Borgward became a helicopter enthusiast after one ride in a Hiller 360 from his factory yard. Knowing of Focke's availability in Germany, Borgward approached him with the suggestion for collaboration. Focke, then with about 20 designers available, divided his team between Brazil and Germany. His best designer now heads the Brazilian team, and Focke directs the work at Bremen.

Next project, according to well-informed German sources, is a 40-passenger troop or civil helicopter.

Guided Genie

Washington—An Air Force is developing a new version of the Genie atomic tipped air-to-air missile incorporating a guidance system, more powerful propulsion unit and longer range. Version of the Genie now in service with USAF air defense F-89 squadrons is rocket propelled but has no guidance system.

MAP image on 4x5 in. glass plate is superimposed with aircraft silhouette on TV screen.

Space Monopolizes Control Study

By Richard Sweeney

Dayton—Flight Control Laboratory at Wright Air Development Center will be asking proposals within a year for space flight technology studies, and funding of new idea studies will be limited, with one exception, to this technology in the future.

These facts were given to 700 persons attending a USAF Control-Display Integration Symposium here last week by Col. John Martin, Jr., chief of the Flight Control Laboratory.

Companies thinking of space flight technology study proposals, Col. Martin said, would do well to think along the lines indicated by the need.

- **Reference and coordinate systems,** and their display.
- **Acceleration control,** in effect an energy management system covering velocity differentials as would be encountered approaching a satellite in orbit with a space ship either inbound or outbound; proper planning of fuel use to produce a change in acceleration magnitude or direction with limited fuel supply and other aspects of ship travel rate.
- **Flight path reference** and its display.

One exception to funding for space work, Col. Martin said, will be for these new idea studies which are definitely to be incorporated into a currently scheduled weapon system, or a new idea study which promises a very large payoff which will be able, on a realistic time schedule, to be incorporated into a presently designated weapon system.

There will be no more developing an idea and waiting for some future weapon system or airplane to come along which can use it.

While space flight is the coming regime, Col. Martin urged the symposium to remember that airplanes still exist and are used. He stressed several additional ideas, such as keeping an assumption labeled as an assumption until proved or disproved, not letting it become a fact just because it has been around a long time. Great use will be made of simulation and analysis in the future, one reason being to put problems in their proper perspective of reality and magnitude. Words will have to be used cautiously; full assurance of their common meaning to speaker and listener will be necessary.

Other developments of the symposium were:

- **Showing by Avion Division** of American Car and Foundry Co. of a cathode ray tube and optical systems for displaying a horizontal situation on two scales of a map with either a moving map and fixed symbol, or a fixed map and moving symbol. Unit would fit in—and Avion is bidding on—the Army-Navy Instrument Program cockpit proposed for Douglas A4D (AW Dec. 30, p. 56).

  Unit will be flight tested in the near future, is slated for a T-37 simulator at Flight Control Laboratory.
- **Report on flight test time** and results to date of two WADC Phase 2 panels (AW July 23, 1956, p. 62) in F-102, by Maj. C. Symonoff emphasizing ease of transition from panel to contact flight. Some 400 hr. have been amassed in flight test of Phase 1 panels.
- **Showing of mockup** of one possible next step in cockpits done by Lear Inc., in which parts of Phase 2 panel are used along with new elements in controls and displays for additional parameters.
- **Report by John Schoeppel** of Lear on future thinking and possible directions, in which the "organ console" philosophy may appear to fully utilize pilot's visual and manual reaches in front and to the sides.

Defense Gets Space, Satellite Approval

By Ford Eastman

Washington—Senate-House conference committee last week gave the Defense Department authority to proceed with the development of missiles, satellites and space vehicles but failed to specifically authorize the proposed Advanced Research Projects Agency through legislation. The Defense Department however probably will delay decisions on any new space programs until firm responsibility for these is established.

The conference committee action, a compromise between the Senate and House versions of the 1958 supplemental defense appropriations bill will permit the Defense Department to go ahead with urgent missiles and space projects already under way but postpones action on establishing ARPA through legislation. Originally the House version of the bill specifically named ARPA, an agency proposed by Defense Secretary Neil McElroy, while the Senate deleted all reference to it.

Congress will delay serious study of ARPA until later when it begins consideration of proposals on overall defense reorganization.

McElroy last week said he is pleased with the compromise and added that he is nearing a decision on the man to head the new agency. These moves in this direction were made last week.

- President Eisenhower asked Dr. James R. Killian, Jr., his scientific adviser, to conduct a special study to determine whether control of space projects should be vested in a military or civilian agency.
- Senate majority leader Lyndon B. Johnson (D.-Tex.) proposed a special bipartisan Senate committee be established to study the same question and to consider all other aspects and problems relating to space exploration. The Senate quickly approved.

Killian Study

Dr. Killian's study will be along similar lines. President Eisenhower said Killian will report on the type of agency needed to handle outer space activities and determine just where it will fit in the overall structure of the government. It will deal with missiles, space vehicles and satellites. The President then will make his recommendations to Congress.

After the President had directed that the study be made, Sen. Johnson introduced a resolution to establish a special committee consisting of members from the Armed Services, Foreign Relations, Appropriations, Commerce, Government Operations and Joint Atomic Energy Committees.

It will be composed of seven Democrats and six Republicans with broad powers to conduct a study of space problems, the control, development and use of astronautical resources, personnel, equipment and facilities. Johnson suggested that the committee report directly to the Senate by bill or otherwise by June 1 or as soon as possible thereafter. The President's recommendations also would go to the special committee.

Senate minority leader William F. Knowland (R.-Calif.) hailed Johnson's proposal as a means of coordinating congressional and Administration efforts. He said it would permit Congress to pass legislation this year.

Meanwhile, under the agreement worked out in the conference committee, Secretary of Defense Neil H. McElroy will have full control over research and development of weapon systems and military requirements. In addition, he will be permitted to engage in space projects authorized by the President for a period of one year.

Why ARPA Was Deleted

The Senate Armed Services Committee deleted the section on ARPA on the basis that its creation is a matter of organization and not germane to a construction bill. In its report, the committee said:

The subject itself covers the broad area of space programs, manned satellites, rocket propulsion, etc., not now assigned to the various services of the Department of Defense. It is the committee's firm conviction that while the Secretary of Defense should be given every possible legal assistance necessary to accomplish his assigned mission, the subject of organization within the Department of Defense should be dealt with in one package. If authority of this type is considered necessary, it should be included in a measure specifically designed to amend the National Security Act of 1947 as amended and such legislation is not properly a part of a construction bill."

What House Proposed

The bill as it passed the House specifically authorized the Secretary of Defense to establish the agency, within the Defense Department and generally outlined its duties. Provisions of the House bill were:

- "It shall be the duty of the agency to engage in advanced, basic and applied research as well as the development of weapon systems for the military departments and engage in such research and development of weapon systems not under the immediate jurisdiction of any military department such as the Secretary of Defense, after consultation with the Joint Chiefs of Staff, may assign to such agency.
- "The agency shall have authority to enter into contracts with persons, corporations, colleges, universities, institutes, government agencies and other organizations the Secretary may approve for advanced basic or applied research, or development of, weapon systems or to engage in such research or development within the agency by using agency employes or consultants.
- "The Secretary of Defense shall assign the weapon systems developed by the agency to such military department or departments for production and operational control as he may determine.
- "Nothing in this provision shall preclude the Secretary of Defense from assigning to the military departments the duty of engaging in research and development of weapon systems necessary to fulfill the combatant functions assigned by law to such departments."

Eisenhower and Space

Washington—Here is how President Eisenhower explained his space program plans to newsmen last week:

"Now this is what I have done. I have gotten a group of fine scientists under the chairmanship of Dr. Killian, actually I have asked him to do it and he is getting the scientists to give for the United States a program of outer space achievement, what seems to be in the realm of possibility and more what is in the realm of probability in the whole scientific area, as distinguished between—against the defense aspects of this business.

"Now, whatever the aspect of the defense space business are now involved will be pushed, just as they have been before, but now under the direction of Mr. McElroy's particular assistant.

"The others there will be a program made out largely in terms of objectives, and with a hope that it will be, of course, accomplished.

"Now, I don't believe—they may say—I think they will make that general rough program of time schedule of accomplishment but they will be also interested in how they will organize in order to do it."

Army's Capitol Hill Prestige Boosted by Satellite Success

By Katherine Johnsen

Washington—Successful launching of the Army satellite skyrocketed the service's stock on Capitol Hill.

It had been steadily climbing since the Soviets' Oct. 4 launching of Sputnik I, as Army listed its missile claims and detailed complaints of being handicapped by Defense Department restrictions. The failures of Navy's Vanguard project further heightened interest in Army's proposals.

Congress Reacts

Except for the brief Korean war period, Army programs since World War II have generally been the main target for budget cutting in military appropriations. A few of the indications that its satellite has paved the way for more favorable action on Army proposals:

• **Downpour of congratulations** from representatives and senators to the Army, particularly the team at Redstone Arsenal that was in charge of development of the Jupiter intermediate range ballistic missile and the satellite. "On too many occasions, we have tended to downgrade the Army and to give most of the credit to the other services," Sen. Mike Mansfield (D.-Mont.), assistant Senate majority leader, said. "For that reason, among others, I am delighted that this momentous event has occurred."

• **Rep. Carl Vinson** (D.-Ga.), chairman of House Armed Services Committee, announced a personal fight to raise spending for new Army weapons and to block a proposed 50,000 man cut back in Army strength.

• **Rep. John McCormack** (D.-Mass.), House majority leader, joined in a protest against restrictions imposed by Defense Department on the size of aircraft Army can buy and operate and the restrictions on its missile programs. Dr. Frederick L. Hovde testified before a House Government Operations Subcommittee that such restrictions on Army to accomplish its missions "is like asking someone to dig a ditch with a teaspoon."

McCormack concurred that "it makes no sense."

Soviet Mi-6 Has Clamshell Doors

Clamshell doors on new Soviet Mi-6 twin-turbine powered helicopter swing full open to admit conventional size Pobeda sedan. Mi-6 reportedly can carry three Pobedas at once. Helicopter is latest model in designs started in 1949 by Mikhail L. Mil.

USAF Jupiter Unit

Washington—Air Force activated the 864th Strategic Missile Squadron at Huntsville, Ala., on Jan. 15 as a unit of Strategic Air Command to be equipped with the Army-developed Jupiter intermediate range ballistic missile. USAF personnel under the command of Col. William C. Erlenbusch have been reporting to his squadron and have begun their training on Jupiter operations. This squadron is scheduled for deployment overseas during 1958, along with another USAF Strategic Missiles Squadron equipped with the Douglas Thor IRBM.

• **Rep. Edith Nourse Rogers** (R.-Mass.) viewed the Army satellite as vindication of Army's arsenal system. "It is just another instance and another proof that we must not scrap our arsenals that we must keep them going if we want to stay ahead of every other country in national defense," she said on the House floor. "They give work to many highly skilled workers and many small businesses. We want small business to go forward. They are invaluable to us."

• **Sen. Richard Neuberger** (D.-Ore.) wrote Army Secretary Wilber Brucker urging him "to restore all lost rank, pay and delay in advancement to Col. John C. Nickerson," who was court martialed because of classified documents he released to the press criticizing former Defense Secretary Charles Wilson.

"The demotion and court martial of Gen. Billy Mitchell, pioneer sponsor of airpower, brought only repudiation to those responsible for it," Neuberger said. "Now that Col. Nickerson's persistence has been vindicated so soon after his punishment, I believe you should revoke the unfortunate penalty which he suffered."

Some Apprehensions

Some congressmen also moved to offset any moves toward over-confidence and complacency that could follow the successful satellite firing.

"I am afraid that we are about to pat ourselves silly in self-congratulation," Sen. Joseph Clark (D.-Pa.) said on the Senate floor. "In my view, Sputnik woke Rip Van Winkle up. I hope Explorer will not put him back to sleep." Rep. McCormack observed.

"It is a little bit disturbing, this tendency to get back into a dream world. Public opinion may be erroneous, but all of us in public life know its influence."

Vigorously concurring with McCormack, Army's retiring research chief, Lt. Gen. James M. Gavin minimized the satellite accomplishment and emphasized that the future will still be difficult. "We were confident in launching Explorer," Gavin said. "In time developments will require more wisdom and more effort in the space field than in getting it up there. It should be emphasized that we are far, far from being out in front."

Gen. Gavin, along with Hovde, testified before a House Government Operations Subcommittee. He warned of "the very great danger" that, in focusing on the space field, the fundamentals of a sound defense will be overlooked. He emphasized that land mobility, radiological, biological and numerous other aspects of warfare are just as dynamic now as rocketry. He said that, with her improvement in weapons for ground forces, Russia's vast superiority in numbers will become an increasing and grave threat, particularly in the case of numerous concurrent "limited" wars over the globe. Armies of the future equipped with advanced equipment will require more, not less, manpower, Gavin said.

Political Repercussions

Land warfare of the future, he said, will compare with that of World War II as World War II did with that of the Civil War.

The Army satellite also had its political repercussions on Capitol Hill. While Democrats continued to point to past failures and prod the Administration to increase the defense effort, Republicans interpreted the satellite as final proof that all has been and is well with the defense program.

"It is the product of a concerted, farsighted program, carefully planned and fully supported by President Eisenhower and our entire national administration," Rep. Carroll Reece (R.-Tenn.), a member of House Armed Services Committee and former chairman of the Republican National Committee, declared in a floor speech.

Rep. Leslie Arends (R.-Ill.), also a member of Armed Services Committee, criticized the Democrats for criticizing the Administration. "Unfortunately, some sought to fan public concern (after Sputnik I) into a hysteria with talk of urgency, emergency and need for crash programs. These various statements were obviously designed to give the people the impression that our whole defense status and planning was being neglected."

Meanwhile, Joint Congressional Atomic Energy Committee moved forward with its bid to place civilian policy direction of the space field with Atomic Energy Commission and expand its own jurisdiction to include space affairs with public hearings on legislation which would accomplish this (AW Feb. 3, p. 37). The hearings will also deal with advanced systems for outer space propulsion. First witnesses were AEC chairman Lewis Strauss and Col. Jack L. Armstrong, chief of AEC's Aircraft Reactors Branch.

Senate Gives Quick Approval To Supplemental Defense Bill

Washington—The Senate last week quickly and unanimously approved $1.2 billion in supplemental Fiscal 1958 appropriations to push top-priority defense projects—primarily missile programs.

Democrats viewed the measure, already approved by the House (AW Jan. 27, p. 27), as "too little and too late." Their position, however, was to make the $1.2 billion available promptly rather than bind it with amendments appropriating funds to push additional projects. Sen. Stuart Symington (D.-Mo.) said:

"The approach of this supplemental bill is essentially piecemeal and therefore unbusinesslike; and that is especially unfortunate because constant defense reprogramming continues to cost the American taxpayers hundreds of millions of dollars a year.

"In addition, time once lost can never be regained—and the importance of facing up realistically to the growing danger cannot be overemphasized.

"For two reasons I nevertheless refrain from submitting amendments: first, any amendments would probably result in delay . . . and secondly, I understand the Administration will come up shortly with another supplemental bill."

Of the total $1.2 billion, $910 million is for Air Force, $350 million for Navy. In addition, Army is authorized to transfer $20 million for research and development on the Pershing solid-propellant missile, follow-on to the Redstone missile, and $20 million for production of second generation corps type missiles—LaCrosse, Little John, and Sergeant.

Navy's allocation is divided: $296 million for construction of the first three nuclear-powered ballistic missile submarines to employ the Polaris missile and $53 million for research, development and facilities for the Polaris program. Air Force funds provide:

• **Support equipment** for intercontinental and intermediate range ballistic missile and missile detection program, $300 million.

• **Research and development** in the intermediate ballistic missile program, $30 million.

• **Construction, $520 million.** This includes $218.6 million for Strategic Air Command alert and dispersal facilities, $112 million for ballistic missile facilities, $160 million for ballistic missile defense facilities and $29 million for the Semi-automatic Ground Environment System.

Symington protested that funds for the following programs should also be included to meet "minimum requirements":

• **At least $900 million for SAC weapons systems**—B-52s, KC-135s, B-58s, and Snark missiles.

• **$400 million to accelerate ICBM and IRBM production schedules**—$30 million for the Titan program and $370 million for the Atlas, Thor and Jupiter programs.

• **At least $150 million** to initiate the expansion and modernization of airlift for the Army.

• **Minimum of $500 million** for three additional Polaris-equipped submarines and five attack submarines.

• **At least $100 million** additional for research and development to take care of deficiencies in military programs.

Both Air Force Secretary James H. Douglas and Gen. Curtis LeMay, USAF vice chief of staff were dissatisfied. Douglas protested that the Joint Chiefs of Staff turned down USAF's request for "urgently needed" funds for B-52 production and acceleration of the Martin Titan ICBM program. LeMay added that funds for these programs also should be made immediately available—$52 million to adapt boosters for the North American X-15 high-altitude research vehicle, $10 million to expedite the WS-110A chemical bomber program, and $200 million for electronics and communication equipment.

New USAF IRBM

Washington—USAF is studying development of a solid propellant intermediate range ballistic missile that would be launched at the extreme edge of the Earth's atmosphere from an aircraft. USAF spokesmen said this air-launched IRBM would be a successor to the North American WS-132 Hound Dog air-to-ground missile now being developed for use from the Boeing B-52. USAF also disclosed that it will shortly test fire the largest solid propellant motors ever built. These solid fueled rockets are believed to be involved in the air-launched IRBM program.

USAF also disclosed that the first Strategic Air Command operational firing of the Bell Rascal air-to-ground missile was made recently from a B-47 with a hit being scored from more than 75 miles away—well within 1,500 ft. circular position target error called for in its design specification. USAF said that, with the nuclear warhead it can carry, the Rascal shot would have completely destroyed the target.

1957 Transatlantic Traffic Over Million

Scheduled airlines carried 1,021,974 passengers, 22% more than 1956; top million mark for first time.

By Glenn Garrison

New York—Finishing strong after a slow-starting year on the North Atlantic, the scheduled airlines topped the million mark for the first time in 1957 with 1,021,974 passengers carried. The total, about 22% above the previous year's, included 53,823 chartered passengers.

Tourist fare traffic which accounted for 739,552 of the 1957 scheduled passengers is expected to be largely displaced this year by the economy class. The new, lower fare goes into effect in April. Majority of carriers, however, are still offering tourist accommodations in varying amounts and combinations.

Year Began Poorly

Traffic figures for the closing months of 1957 seemed to show a trend toward a long-sought goal of the airlines—spreading out the peak season. Eastbound total for September was 39,678, up from 28,805 the previous September, October's increase in this scheduled traffic was 5,565 passengers. November was up 3,941 passengers and December was up 4,585 passengers.

Were the carriers' long time efforts to promote off-season travel beginning to really pay off? Possibly, but another factor also was to be considered: the year's slow start (AW Oct. 28, p. 38).

One major travel agent, for example, experienced heavy cancellations of his May, 1957, bookings during January. This reflected the uncertainty caused by the fall, 1956, Suez crisis. But in late February, most of the same people re-booked and many others who had apparently waited in the first place went ahead with their plans. This delay had the effect of moving a good deal of business further into the season.

The same agent, however, believes the trend into the fall is genuine and finds it encouraging. He used to receive relatively few bookings after Aug. 1, but now finds more business coming later. One source is the increasing number of groups that go aboard for business or professional conventions instead of holding them in the U. S. They can find better accommodations in the off season. Many, but not all, of these groups use chartered services.

Another big factor in the record results for 1957 was the 27% increase in westbound traffic, chiefly in low-fare immigrant business. Total westbound was 541,385: 118,227 first class and 423,158 tourist.

Eastbound scheduled traffic totaled 426,766, of which 110,372 passengers were first class and 316,394 were tourist. The eastbound increase over 1956 was about 18%.

The carriers made 23,751 scheduled flights during the year, most of which were of mixed configuration. The totals: 14,194 mixed, 6,438 all tourist and 3,119 all first class.

First Class Traffic

First class traffic, which has climbed less spectacularly than tourist traffic but nevertheless has been comfortably increasing over the years, totaled 228,599 in 1957, a rise of about 9%.

The transatlantic carriers offered a total of 1,450,004 seats during the year for an overall load factor of about 67%. Westbound, the load factor was up 4% to 74%; eastbound, it stayed at about 59%.

Individual results of the top five North Atlantic carriers, ranked by their total traffic are as follows:

- **Pan American Airways** carried 277,937 passengers, up from 200,432 in 1956. The airline's 1957 traffic split: 119,487 eastbound, 158,450 westbound. Pan American predicts an increase of 200,000 passengers for all the airlines this year. The carrier's share of the 1957 traffic between the U. S. and Europe was about 31%.
- **Trans World Airlines'** total was 153,641 passengers, an 8.5% increase. Of the total, 27,667 were first class travelers and 125,794 were tourist fare passengers.
- **British Overseas Airways Corp.** carried 114,871 passengers, up from 88,678 in 1956. BOAC's passengers split: 34,782 first class, 80,089 tourist.
- **KLM Royal Dutch Airlines** carried 91,000 passengers a 29% increase. The airline's share of the transatlantic traffic was 8.9% in 1957, up from 8.4%.
- **Air France's** traffic totaled 75,160 passengers, up from 58,532 in 1956.

Scandinavian Airlines System actually nosed out Air France with about 87,000 passengers if the Los Angeles-Copenhagen polar route is included.

Polar figures in the past have not been incorporated in North Atlantic totals. SAS has become uncommunicative about its polar statistics since Pan American and TWA began competing on the route. The Scandinavian carrier, formerly eager to talk about its polar route results, now declines to split the totals off from its overall transatlantic operation. The airline carried 14,907 polar passengers in 1956.

Trans-Canada Airlines carried 49,109 passengers, up from 40,043. Sabena Belgian Airlines increased its total 63% to 37,000.

Whatever else results from the introduction of economy-fare service, it would appear likely to add a burden to scheduling personnel.

Juggling of the economy, tourist, first class and de luxe accommodations provides a number of combinations approached in different ways by the various carriers. Examples:

- **SAS is going** the whole way and discarding the tourist class altogether. Peak weekly schedules from New York will include 15 all-economy flights in Douglas DC-6Bs and DC-7Cs, 14 flights mixed between economy and first class, and two all first-class flights. The airline considers the two-class limit (excluding de luxe) a more practical arrangement than mixing three classes, thus avoiding the "confusion" of providing several different types of meal and drink services.

  The economy class passenger is limited to free sandwiches, mineral water and soft drinks but cannot get alcohol or hot food either gratis or at a price, while in flight. His seat pitch is also restricted to 34 in. The tourist passenger gets hot meals free and can buy drinks, while the first class passenger's meals and drinks are free.
- **Pan American** is mixing up its passengers in various ways, but in no case putting the economy travelers with more than one other class. There will be six different configurations of weekly flights in the airline's operation this summer: 15 all-first-class Boeing Stratocruiser flights, 14 all-economy Douglas DC-6Bs, seven all-tourist Douglas DC-7Cs, 16 first-and-tourist 7Cs, 12 first-and-economy 7Cs and 6Bs, and 14 tourist-and-economy 7Cs.
- **TWA will mix** tourist and first in 27 Lockheed Super C Constellation and 1649A Jetstream flights first and economy in 19 flights, and will operate 18 peak all-economy 1049 Super Constellation flights.

  The airline has scheduled no all-first-class flights.
- **KLM Plans** 14 all-economy flights in 1049 and Super H Constellations, plus three economy and first-class flights and 16 first class and tourist flights. No all first class.
- **BOAC is going** to mix well before serving except in its first class flights. Thirty-seven weekly flights from the U. S. and Canada will contain economy seats and various combinations of first and/or tourist passengers.

  Two Qantas Empire Airways Ltd. interchange flights from San Francisco will not provide economy seats, nor will the daily Monarch first-class flights from New York. The mixed flights will be in Bristol Britannia and DC-7C equipment.
- **Air France** will keep its economy passengers separate in—initially—four weekly Lockheed 1049 flights carrying 91 passengers. Thirteen other flights beginning in April will mix tourist with de luxe and tourist with first class passengers. One flight will mix only first class and de luxe passengers.
- **Sabena will mix** economy, tourist and first class in a 43-10-15 ratio in 16 DC-7C flights, and will run seven all-economy 97-passenger flights in 1049 equipment.
- **Lufthansa** plans to mix all its 15 flights in 1049s and 1649s three ways.
- **TCA will mix** its flights economy-tourist-first.

The above schedules are tentative. In fact they may prove to be extremely so. Some airlines believe the tourist class business will slow to a trickle in competition with the lower fare.

Actual implementation of the economy fare still requires approval of governments involved.

Some airlines who were not enthusiastic about the third class fare may take some oblique steps to ease the economy passenger's trip, especially as concerns his thirst. Swissair, for example, plans to sell small bottles of liquor to passengers before they board their planes. Once in the air, a glass and mixer can be obtained. At least one other foreign-flag airline is planning similar liquor service for low-fare passengers.

Two carriers have been allowed exceptions to the economy seat limitations by International Air Transport Assn.: El Al Israel Airlines can carry economy passengers in seats with 36 in. pitch instead of 34 in. and Iberia Spanish Airlines can use a 37-in. pitch in the same class until June 30, 1958.

North Atlantic 1957 Scheduled Passengers

	EASTBOUND			WESTBOUND		
PASSENGERS	**First**	**Tourist**	**Total**	**First**	**Tourist**	**Total**
Jan	6,831	13,328	19,359	8,228	21,609	27,837
Feb	6,308	11,210	17,518	5,918	19,123	25,041
Mar	8,387	16,443	24,830	8,382	29,056	37,438
Apr	9,425	21,684	31,109	7,519	25,229	32,748
May	11,118	32,495	43,613	9,329	30,878	40,207
June	12,607	55,997	68,604	9,932	42,767	52,699
July	11,137	49,823	60,960	9,387	41,278	50,665
Aug	8,362	32,837	41,199	13,439	63,515	76,954
Sept	10,904	28,774	39,678	15,592	60,401	75,993
Oct	9,830	18,407	28,297	14,139	39,963	54,102
Nov	8,491	14,818	23,309	10,141	26,919	37,060
Dec	7,480	20,518	27,998	8,221	22,420	30,641
Totals	110,372	316,394	426,768	118,227	423,158	541,385
SEATING CAPACITY						
Jan	12,243	27,366	39,609	12,311	28,534	40,845
Feb	11,126	24,930	36,056	11,315	25,968	37,283
Mar	12,571	31,821	44,392	12,563	33,096	45,659
Apr	13,253	32,709	45,962	13,238	33,605	46,843
May	14,814	45,415	60,229	14,799	44,939	59,738
June	18,607	64,253	80,860	16,921	59,364	76,285
July	17,624	63,696	81,320	17,746	62,327	80,073
Aug	17,690	65,265	82,955	17,560	68,063	85,643
Sept	18,095	62,330	80,425	18,355	65,374	83,729
Oct	18,277	46,734	65,011	18,394	49,635	64,029
Nov	17,516	34,459	51,975	17,497	35,773	53,270
Totals	186,872	533,155	720,027	188,277	541,740	730,017

Bristol Stops Orion Development For Lack of Government Support

London—Development of Bristol Aero-Engine, Ltd.'s Orion engine—the first two-spooled, supercharged turboprop—has been stopped. This decision was announced by the engine company following notice of the government's intention to withdraw support.

"Although we had put quite a lot of our own money into it," a company official told AVIATION WEEK, "we just cannot proceed on our own."

Decision terminates a development program which has logged some 2,400 test hours, 250 of them in flight since the engine first ran Dec. 10, 1955. "We were just over half way and the worst was over," a company official commented.

"Current obsession with turbojets" and uncertainty about long term requirements for long range aircraft account for lack of interest in the project, officials believe. But Bristol is confident that "large freighters will stay with turboprops" and will particularly want gated engines of the Orion formula in the near future. "We have cocooned Orion, not abandoned it," AVIATION WEEK was told.

One Firm Order

Only firm order for the engine stemmed from the CL-44 requirement, for which Canadair, Ltd., had already received an order of eight from the RCAF. The CL-44 is a derivative of the Bristol Britannia airliner.

At Montreal, a Canadair spokesman said RCAF and company officials are discussing installation of another engine but said no decision has been reached. Use of the Rolls Royce Tyne is being "seriously considered although the Orion was the best engine available," he added.

The spokesman said a decision is expected to be made soon, to eliminate any possible slowdowns in production.

British Overseas Airways Corp. had placed no order for the Orion engined Britannia 400 series. It was on the strength of the BOAC requirement that the Ministry of Supply decided to sponsor development of Orion, bearing in mind the potential of the series as troop carrier aircraft.

Stretch Proteus Engine

Plans of Short Brothers and Harland Ltd. also were based on Orion availabilities for its Britannia freighter conversion program (AW Nov. 11, p. 48), and there was a strong possibility that the Britannia 300 series would have been re-engined with Orions.

Unofficially, Bristol believes it can stretch Proteus engine to give another 20% of output. This would help bridge the sea level gap between the two engines.

Proteus 755 series currently develops 4,120 eshp (equivalent shaft horsepower) falling to 2,200 eshp at 30,000 ft. This stacks against 5,500 eshp for Orion which falls to 3,400 eshp at about 30,000 ft. But the mass flow of

the supercharged engine (80 lb./sec., is twice that of the Proteus.

This feature would have enabled it to take off at part throttle and maintain sea level thrust up to 22,000 ft., the powerplant being able to retain the same propeller and reduction gear as used on the Proteus.

The design permits a very high compression ratio—believed to be between 10 and 11 to one—and leads to outstanding reductions in fuel consumption with relatively low gas temperatures the company claims. The latter feature in particular, Bristol hoped, would enable the engine to reach a 2,000-hr. life fairly quickly.

According to Bristol, other operational advantages of a gated engine include "the ability to take off without restriction of payload from any airfield regardless of altitude and temperature as well as a major increase in cruising speed."

Orion Was Replacement

Orion originally was planned as a packaged replacement for Proteus which would not involve wing structural modifications. This was practical largely because with neither engine does the jet pipe go through the spar.

It was known that the company had thought of phasing the Orion replacement operation into the normal major overhaul program on the Proteus engined 300 series. This would mean accepting a "slight" drag penalty with the original wing contour which would be incurred due to the proximity of the higher cruising speed to critical Mach number. The full potential of the supercharged engines which should lead to a 50 kt. increase in the case of Britannia, could not be exploited without raising the wing critical Mach number. One idea that Bristol was known to have favored for the 700 series was the use of an extended leading edge.

Orion utilizes many well tried elements of Proteus, Olympus and Orpheus engines. It has the same propeller and reduction gear as Proteus, the low pressure compressor is very closely related to the main compressor of the Orpheus turbojet and the remainder of the engine is "virtually" a half-scale geometrically similar version of the Olympus turbojet, its 80 lb./sec. mass flow comparing with the 160 lb./sec. of Olympus. Many aspects of the control system also are basically similar to those on the Proteus.

ALPA, Engineer Battle Reaches Climax

By L. L. Doty

Washington—Fight between airline pilots and flight engineers over whether third crew members of jet aircraft will be qualified as pilots is scheduled to reach a climax this week as both sides present their cases to a Presidential Fact Finding Board in New York.

The growing battle between Flight Engineers' International Assn. and the Air Line Pilots Assn. that has been smoldering for more than a year is now boiling down to a jurisdictional dispute. Outcome of the arguments before the Fact Finding Board will be viewed by industry as a test case that will set a pattern for future bargaining with the two unions on the third crew member issue.

Appointment of a Fact Finding Board to review the case resulted from a breakdown in negotiations between Eastern Air Lines and the Engineers. FEIA will appear before the Board today and ALPA, also currently bargaining with Eastern, will take the stand tomorrow.

ALPA-Engineer Dispute

At stake is the final determination as to whether third crew members on jet transports will be qualified as pilots or continue to hold their professional status as mechanic engineers. ALPA contends engineers are unnecessary on jet transports because of the relatively simpler operation of turbine engines over piston engines. The union first revealed its campaign to invoke the pilot requirement at its 14th Biennial Convention in Chicago (AW Nov. 18, 1956, p. 39).

The engineers' stand is that safety and efficiency of jet transport operations will be substantially increased through the use of flight engineers with or without pilot qualifications (AW Nov. 18, p. 47).

Proposed Civil Air Regulations permit either category to serve as flight engineers.

Failure to settle the dispute between the two unions has made the airlines the victims of a tight squeeze play. An Eastern Airlines spokesman told AVIATION WEEK that his company has been blocked from reaching a peaceful settlement on other issues by the current squabble between the pilots and engineers.

Industry Problem

Industry realizes that no matter what agreements are made across the bargaining table with either of the two unions, the third crew member problem stands as a threat to the operation of business. It will remain a threat until the issue of jurisdiction is resolved.

Late last year, ALPA warned Pan American World Airways that its pilots would not fly jet transports until the crew complement problem is settled to the union's satisfaction (AW Dec. 9, p. 47). The airline signed a contract in November with the Flight Engineers' International Assn. providing for flight engineers on jet transports (AW Dec. 2, p. 45).

The contract runs until 1960, and Pan American expects delivery of the first of its Boeing 707s late this year or early in 1959.

'Raiding' Charge

The breach between the two unions was further widened last week when the engineers' union asked the Executive Council of the AFL-CIO to suspend ALPA from the union for alleged "raiding and strike-breaking activities." The AFL-CIO executive council meeting in Miami last week, appointed a three-man committee to study the engineers' protest and report its findings back to the Council.

George R. Petty, Jr., FEIA president said he based his actions on a statement which he attributes to ALPA that describes the pilots' organization as a "professional group and not a union." Petty further charged that ALPA has said it will not respect any picket lines of any union.

He accused the pilots of making bargaining for the engineers difficult by telling management they would perform the engineers' work if FEIA went out on strike.

ALPA has invited the engineers to join its organization but FEIA has resisted the offer on the ground that the engineers would step in at the bottom of seniority lists. Engineers claim "this is a pure and simple case of pilots getting job security at the cost of the flight engineers and the safety of the traveling public."

Navigator Dispute?

Another similar labor relations problem may be in the making as the airlines specify Doppler navigation systems (AW Feb. 4, p. 83) for overwater jet transport operations, replacing professional navigators. At least two airlines have placed firm orders for Dopplers with one company planning to retain navigators for about two years following the introduction of the new equipment.

During that time, pilots are expected to become proficient enough in the use of the Doppler system to permit the release of navigators as crew members. Four U.S. airlines with routes covering

overwater areas are known to be in the Doppler market.

At present both Air Line Pilots Assn. and the Flight Engineers' International Assn. are involved in disputes with Eastern Air Lines. Engineers have charged that pilot pressure on Eastern has delayed the signing of a contract between the engineers and the company that would guarantee a flight engineer in jet transport cockpits.

The White House stepped into the argument between Eastern and FEIA late last month in time to avert a threatened walk-out. President Eisenhower acted under emergency powers authorized under the Railway Labor Act after he was told by the National Mediation Board that the dispute threatened a disruption of interstate commerce.

The three-member fact finding board appointed by the President has 30 days in which to file a report. If Eastern and the engineers union have failed to reach an agreement 30 days after the report is filed, the President may submit recommendations for further action to the Congress.

Talks between the company and the union with the National Mediation Board broke down when the engineers expressed complete dissatisfaction with the progress made during the "informal" discussions. Under Civil Aeronautics Board regulations, flight engineers are required on all aircraft of DC-6 size or larger. Consequently, a walkout of the engineers could result in a serious cutback of operations. Eastern is also presently negotiating with the International Assn. of Machinists.

ALPA is also involved in emergency mediation with three other airlines—Western, Central and American. Negotiations with American on rules, working conditions and pay are now in recess.

Central is in mediation with ALPA on the same issues with no indication late last week that much headway toward settlement had been made.

Emergency conference with Western Air Lines broke down last week, and pilots announced a Feb. 6 strike date. In a last-ditch move to prevent a strike, Western asked for a federally-supervised balloting by ALPA members on a National Mediation Board compromise plan which ALPA bargaining agents have rejected.

Issues include rules, pension, working conditions and pay.

Last month ALPA and National Airlines reached an agreement on a contract that provides for pilot pay up to $26,800 annually. Under the new contract a senior DC-8 turbojet pilot will gross $2,234 per month or $26,800 a year and a senior pilot on the Lockheed turboprop Electra will earn $1,900 per month. A pilot with top seniority on a DC-7B will be paid $1,800.

British Modify Two Transport Autopilots

London—Autopilots used in Viscount and Britannia turboprop transports have been modified to eliminate aileron control locking in flight, AVIATION WEEK has learned.

The action follows an in-flight incident last month involving a Britannia aircraft on a test flight. Bristol Aeroplane Co. has revealed that the ailerons locked in a banked condition. There was no recovery response, AVIATION WEEK was told, until all the aircraft's electrical units were switched off.

A British European Airways Corp. spokesman said modifications to its Viscount autopilots "obviate a condition whereby the aileron servos become permanently energized." Modifications, said to be "relatively simple," have been incorporated in Viscounts and Britannias.

Makers of the autopilot, Smith's Aircraft Instruments Ltd., declined to give details of the modifications.

According to BEA control experts, Viscount modifications involved rewiring the servo amplifier circuits so that no one electrical fault could lead to this condition.

Such a malfunctioning could induce one of two conditions:

- **Autopilot** controlling the aircraft when the pilot thought it wasn't.
- **Aileron servos** remaining energized with the autopilot switched out, which would lock the ailerons.

This particular type of malfunctioning in the circuits of all types of autopilot is always particularly guarded against in the design," a BEA expert told AVIATION WEEK.

"The sort of thing that tends to happen," he continued, "is that modifications made in the system to correct for one fault can lead to unsuspected characteristic changes elsewhere."

With the present modification, BEA experts told AVIATION WEEK, the Viscount pilot could "with one hand" override the aileron servos, which develop only about 20 ft./lb. torque.

On Britannia aircraft, the aileron servos develop about twice that torque and manual override thus "would present very great difficulties," AVIATION WEEK was told.

CAB Fare Increase Is Effective Today

Washington—Scheduled trunk and local service airlines last week filed for an average 6.6% fare increase to become effective today.

Responding to a Civil Aeronautics Board announcement that it would permit an across-the-board 4% fare increase plus a $1 charge on all tickets (AW Feb. 3, p. 43), the 25 U.S. airlines made a joint filing Wednesday through the Air Traffic Conference of America.

Most airlines termed the increase too small to rescue the industry from its critical financial condition.

The fare increase will apply on all first class and coach rates. Tickets purchased prior to Feb. 10 for use after that date will be subject to the increase.

Second Electra Rolls Out

Second Lockheed Electra turboprop transport is rolled out at Burbank, Calif. First flight is scheduled for Mar. 31, but probably will come sooner. Aircraft has relatively large windshield area, plus skylights above the flight station. Span of 31 ft. 2 in. between main landing gear is expected to add to aircraft's landing characteristics.

First Long Flight For Il-18 Moscow

Russia's Il-18 Moscow transport made its first long-range test flight in January. Four turboprop transport flew the 745 mi. from Moscow to Krasnodar in 2 hr., 13 min. Twenty-five of plane's 75 seats were removed and over 100 instruments installed to record behavior of 760 different parts and assemblies in the plane. Russians say aircraft will maintain an altitude of 26,240 ft. on three engines and 16,400 ft. on two engines. Note ground handling equipment parked near plane (below).

Northeast Disclosure Spurs Plan For 'Anti-Leak' Bill by House Unit

Washington—Senate Permanent Investigating Subcommittee last week called for legislation that would make the disclosure of information in an adjudicative matter a criminal violation. The proposed legislation stemmed from last year's investigation of the leak of a Civil Aeronautics Board decision in the New York-Florida route case.

Criticized Witnesses

In its report, the subcommittee cited two leaks of the Board vote on Aug. 2, 1956, that granted a New York-Florida route to Northeast Airlines. Although it failed to establish any source of the leaks, the subcommittee criticized four specific witnesses who testified in the public hearings and charged that "one or more of the 25 (Board) employes who were present when the secret vote was taken apparently lied."

The subcommittee began the investigation when it was learned that some 24,000 shares of Northeast Airlines stock were traded on the American Stock Exchange on the day following the Board decision and prior to any public announcement. According to the subcommittee, only 500 shares per day were traded on the average day prior to the "leak."

The subcommittee pointed out that the Board has a regulation prohibiting such leaks but emphasized that it carries only an administrative dismissal from service. It proposed legislation that would make it a criminal violation for "any employe in a regulatory agency to knowingly and wilfully disclose any improper information with respect to any matter pending before such agency for adjudication."

The group also said Board members should be afforded the same protection as a judge in a court of law and proposed legislation that would make it a criminal violation for "anyone to attempt to influence any adjudication in a regulatory agency" by making any presentation to any "Board member individually without notifying other interested parties."

Sawyer 'Evasive'

Presumably, the report closes the celebrated leak case with no direct accusations against any individuals concerned.

Former Board executive director Raymond Sawyer was criticized for being evasive in his testimony and for hindering the work of the Senate subcommittee.

Three other individuals were criticized for being either uncooperative or uncommunicating.

Sawyer, who resigned from the Board shortly after the hearings were closed, is now with the International Cooperation Administration in Addis Ababa, Ethiopia.

SHORTLINES

► **Braniff Airways** has begun non-stop Douglas DC-7C service between Texas and New York. The new service leaves Dallas at 9:15 a.m. and 5:15 p.m. CST and arrives in New York at 2:35 p.m. and 10:35 p.m. EST respectively. On the return flights, departures are 8:30 a.m. and 4:10 p.m., with Dallas arrivals at 12:35 p.m. and 8:35 p.m. CST respectively. Braniff also has begun using International Airport for its South American interchange flights with Eastern Air Lines.

► **British officials** are studying a German monorail system as a possible link between the center of London and London Airport. British are evaluating the trial of a monorail which recently began experimental service at Cologne. An official of the British Ministry of Transport and Civil Aviation says that rigorous tests will have to be completed before the monorail can meet the safety requirements necessary for installation in the London area.

► **Delta Air Lines** President C. E. Woolman says "the traditional flow of air freight from North to South and East to West eventually may be equalized, or possibly reversed," by the movement of industry to the South and West. Last year, almost 100 new plants were relocated or built in the Southeast and Southwest.

► **Japan Air Lines'** new fleet of Douglas DC-7Cs, which will be added to the carrier's transpacific routes on April 1, are expected to cut as much as five hours off the flying time between San Francisco and Tokyo. Departures from San Francisco will be every Sunday, Tuesday, Thursday and Saturday at 1:20 p.m. PST, with arrivals in Tokyo scheduled for 7:20 a.m. Tokyo time, two days later after crossing the International Date Line. All flights stop over in Honolulu.

► **Trans World Airlines** plans to increase its economy fare service to Europe from 44 to 74 flights a week during the peak summer travel season this year. In addition to Lockheed Super Constellation all-economy service, the new low fares will be offered beginning April 1 aboard the long range Lockheed 1649 Constellations flying nonstop to Shannon, London, Lisbon, Paris and Frankfurt as well as from the West Coast to Paris and London. The new fares which are subject to government approvals, will bring the New York-Paris fare to $489.60 for the roundtrip and the New York-Rome roundtrip flight to $591.50.

AIRLINE OBSERVER

► Airline stocks moved sharply upward almost immediately after Civil Aeronautics Board announced its decision to grant a 6.6% fare increase (AW Feb. 3, p. 43). Biggest gains were registered by American, Eastern and Capital, the latter receiving added impetus from its plan to purchase nine Convair 880 turbojet transports (AW Feb. 3, p. 40). But once the full meaning of the increase was fully interpreted by Wall Street observers airline stock activity fell back into the sluggish pattern that marked performance during the latter part of 1957. Most investors agreed with the Air Transport Assn. that the fare boost was "too little, too late." However, approaching target date of introduction of jet transports may spark investor interest in airline stocks later this year.

► Best guess as to when Russia will make its first solid bid for a bilateral agreement with the U.S. for a New York-Moscow route can be based on production dates of the Tu-114 turboprop transport. Russia will inaugurate the competitive service only with an aircraft that will out-perform any transport the U.S. is capable of putting into service. Russians believe the Tu-114 will achieve this. This fall, Aeroflot, Soviet-owned airline, will put its Tu-104 turbojet against British European Airways Viscount turboprops when Moscow-London service begins.

► Civil Aeronautics Board Great Lakes-Florida Service Case does not include Great Lakes cities of Milwaukee, Minneapolis, Rochester, N. Y., or any city in Michigan other than Detroit. The case does involve most North and South Carolina cities, all of which have been involved in all three of the last three CAB major route cases. Rochester was considered to be too far east to be covered by the New York-Florida case and is now considered too far west for the Great Lakes case. Rochester, Minneapolis and Milwaukee have defense ties with research and development centers in Florida. Dayton, with close ties to missile testing centers in Florida and an intervenor in the Great Lakes case, says it now has no direct commercial air service to the South, Southeast or the Piedmont area.

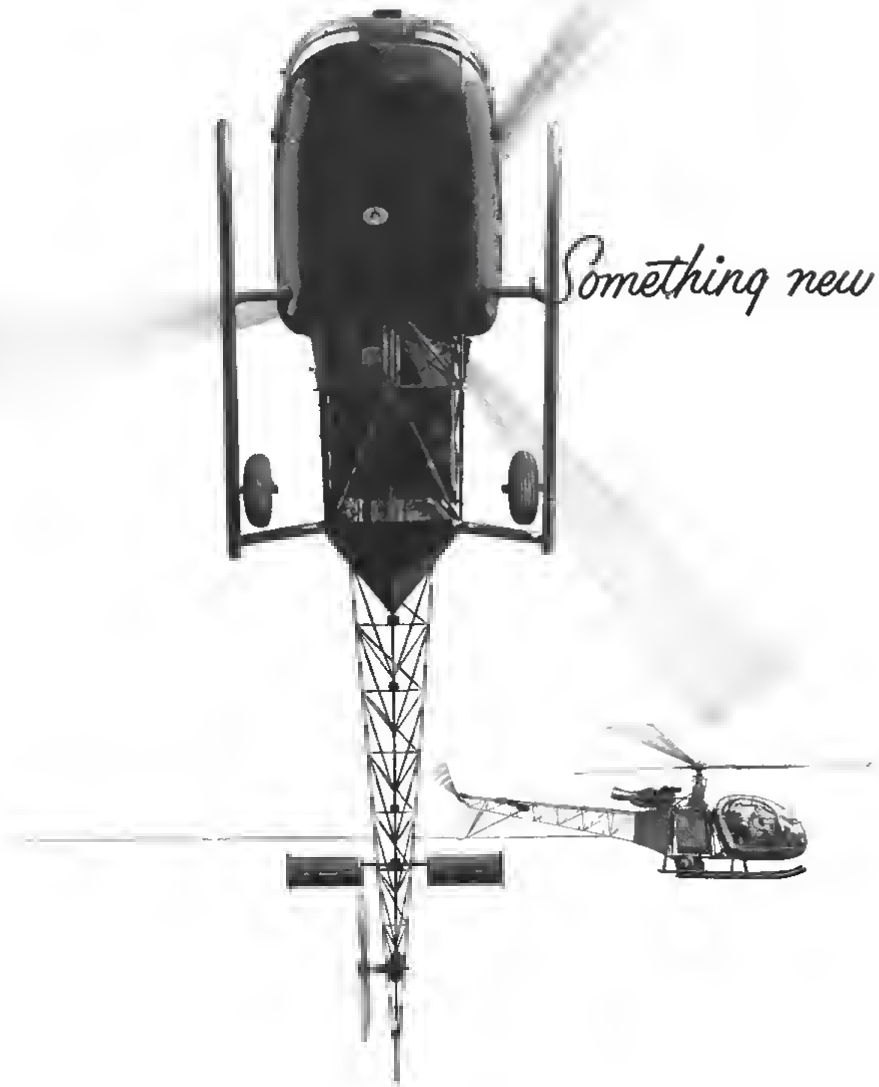
► Transcontinental, privately-owned Argentinian airline will begin Buenos Aires-New York service in April, using three Lockheed 1049Hs on lease from California Eastern Aviation. Last month, California Eastern was authorized by the Civil Aeronautics Board to operate the three Lockheeds over the route "on Transcontinental's behalf." The Board also authorized California Eastern to hold a stock interest in Transcontinental for a period of five years. In another CAB order, California Eastern was granted authority to lease three Lockheed 1049Hs to Hughes Tool Co.

► Civil Aeronautics Administration has warned that amateur rocketry is posing a new hazard to air travel. CAA is asking that all proposed launchings by young amateur scientists be checked out with CAA inspectors and local police and fire departments to prevent any rocket explosions on airways or in the vicinity of airports.

► Civil Aeronautics Board has refused to subject air freight forwarders to minimum rates set for direct air carriers. The Board was split three-two on the issue with dissenters Chan Gurney and Harmar Denny calling for an end to the "unfair competitive conditions" in the freight field arising from the "application of the Minimum Rate Order to direct carriers and not to forwarders."

► Airways Modernization Board has let contracts to the Airborne Instrument Laboratories and the Franklin Institute Laboratories for a detailed analysis of air traffic flow within a 50 mi. radius of the New York air route traffic control center. The study includes plans to photograph continuously the New York center PPS-8 radar scopes and the ASR radar scopes at Newark and LaGuardia to get a permanent record of aircraft movements for later analysis.

► Hearing applications of Southwest Airways, Catalina Air Transport and Los Angeles Airways for service from the Southern California mainland to Catalina Island have been consolidated by the Civil Aeronautics Board.



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The Alouette, miles and years ahead of any other helicopter in the air, is completely revolutionary. It embodies many remarkable features which represent the newest advances in modern European engineering.

Designed in France by Sud Aviation, the Alouette is presently assembled and marketed by Republic Aviation's newly formed Helicopter Division which parallels the Alouette in originality of concept ➤➤➤ Republic's Helicopter Division is the first organization of its kind to devote its facilities primarily to commercial helicopter needs. Complete manufacture of the Alouette in the United States is Republic's ultimate, short-range goal ➤➤➤ The Alouette has already built up an impressive flight log of more than 26,800 miles throughout its U. S. tour. During its demonstrations in 31 cities to commercial air transport companies, feeder line operators and private enterprise, it proved its superiority conclusively . . . both economy-wise and flight-wise.

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Thor Leaves Launching Pad, Forms Twisted Vapor Trail

Thor, Air Force intermediate range ballistic missile, leaves its launching pad (above) in recent firing. In photo below, left, twisted vapor trail behind missile (visible in extreme upper left) suggests deviation from intended flight path. Below right windblown vapor trail remains in air over Cape Canaveral. After stating that missile had landed in pre-selected impact area, Air Force reported that the flight was not completely successful."

Sled Track May Cut Missile Air Failure

By Russell Hawkes

Holloman AFB, N. M.—New 35,000 ft. rocket sled track at the Air Force Missile Development Center here promises a cut in flight failure rate of new missiles. Experts here point out that the Fairchild Goose successful from its initial flight was the first missile to be completely track tested.

New track, scheduled to open in May, will enable USAF and contractors to approximate operational stresses under good conditions for data collection without having to write off the test specimen. Components which fail can be examined afterward.

Acceleration Test

While it will be possible to do some aerodynamic testing of a type that can't be done in a wind tunnel, the primary purpose of the track is to subject missile and aircraft systems, including the pilot, to carefully controlled accelerations. Onset rates and cumulative loads can be simulated better on the track than by any other means.

It would be difficult, but perhaps not impossible, to track test a complete intermediate range ballistic missile or intercontinental ballistic missile. Because the 1G apparent acceleration of gravity would be acting laterally rather than longitudinally, as it does during the early part of powered flight, simulation would be less than perfect. With a liquid propellant rocket, it also would be difficult to avoid blowing up the engine at light off because, in the horizontal position, excess fuel is not free to drain out of the chamber as it does when the rocket stands vertically on the pad.

It might be possible to track test powerplant and fuel systems while operating by designing a chamber especially for horizontal firing without disturbing design parameters of the system.

Reach Mach 4

A track 35,000 ft. long allows a sled to reach Mach 4. Terrain off the end of the Holloman track is level enough to permit extension of the track to 120,000 ft., if necessary.

A sled on the 35,000 ft. track can carry a 30,000 lb. payload at something less than maximum speed. Duration of runs will be about 18 sec. Accelerations up to 50Gs and deceleration up to 200Gs are possible. Variable water braking also enables track engineers to program the rate of onset of deceleration.

EMBANKMENT explodes when rocket sled carrying missile test model smashes off end of Holloman AFB track in impact test. Controlled braking was not tried.

TRACK rails (above) are aligned to accuracy of .005 in. When old 5,000 ft. track at Holloman was torn up and tie-downs broken, section below bent against web. Reason is unknown.

What's new in TITANIUM alloys:

Advances in aviation technology have happened so swiftly that engineering materials can no longer be selected for their broad use, but rather for the specific tasks they perform.

Today, in the face of tight budgets, the *right* material is the only sound solution to any given problem. Patch-work design, engendered by second-best materials, can only result in second-best aircraft and missiles in uniquely critical times.

To meet the constant tightening of design requirements, Titanium Metals Corporation of America has opened wide new areas of alloy development. This means heat-treatable bar stock with *guaranteed* capabilities, higher temperature ceilings, broad new strength ranges.

Q. Are the guaranteed heat-treat alloys new?

A. The alloys are not. They have a production history of four years and a wealth of technical data to support them. Recent development of their full heat-treat capabilities has produced such dramatic results that they are considered new.

Q. What are the heat-treat alloys?

A. Ti-155A (5.5% aluminum, 1.5% iron, 1.5% chromium, 1.1% molybdenum) the highest strength bar and forging stock commercially available, and Ti-6Al-4V (6% aluminum; 4% vanadium), which in the annealed condition has already won wide designer confidence. Samples of *guaranteed* minimum heat-treat capabilities show:

	Ti-155A	Ti-6Al-4V
Section size: Up to 1"		
Ultimate Tensile Strength (psi)	170,000	160,000
0.2% Yield Strength (psi)	155,000	150,000
Elongation, % in 4D (Long)	10	10
(Trans)	8	8
Reduction in Area, % (Long)	20	25
(Trans)	15	20

Detailed information on Ti-155A is presented in a 20-page TMCA Engineering Bulletin. Additional data on Ti-6Al-4V, such as fatigue characteristics and guaranteed heat-treat capability are also available.

Q. Are there other new alloys?

A. The leading alloys nearing commercial volume are Ti-8Al-1Mo-1V, a bar stock offering excellent elevated-temperature creep strength to 1000°F, and Ti-4Al-3Mo-1V. The latter, now being produced and evaluated by the Department of Defense sheet rolling program, is designed to fill the need for high strength sheet alloy which can be formed in solution-treated condition and aged to strengths of 175,000 psi. When compared to other high-strength titanium alloys, Ti-4Al-3Mo-1V combines improved formability with outstanding elevated-temperature strength and stability.

Typical Properties — Ti-4Al-3Mo-1V

Condition	Temp °F	0.2% YS psi	TS psi	Elong % in 2"
Solution treated	Room	94,000	135,000	14
Solution treated and aged	Room	163,000	175,000	5
	200	142,000	169,000	8
	400	126,000	152,000	8
	600	111,000	140,000	7
	800	98,000	127,000	9

Q. How will these alloys raise temperature limits?

A. Ti-8Al-1Mo-1V is a good example. Although its short-time elevated temperature tensile properties are similar to Ti-6Al-4V, this new alloy offers as much as a tenfold increase in creep strength between 600°F and 1000°F, as shown:

Creep Comparison Between Ti-8Al-1Mo-1V and Ti-6Al-4V

Alloy	Annealing Treatment	Temp (°F)	Stress (psi)	Time (Hrs)	Def (%)
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	850	50,000	300	0.42
Ti-6Al-4V	1300°F (2 hrs) AC	850	50,000	300	3.6
Ti-8Al-1Mo-1V	1400°F (24 hrs) AC	950	15,000	300	0.16
Ti-6Al-4V	1300°F (2 hrs) AC	950	15,000	300	4.3

Now being evaluated by engine manufacturers, Ti-8Al-1Mo-1V appears to answer the need for light-weight strength at steadily higher temperatures. Data on both Ti-4Al-3Mo-1V and Ti-8Al-1Mo-1V alloy are available from TMCA.

All these excellent new alloys have boosted still higher titanium's major advantages of light weight, great strength, superior temperature characteristics, and outstanding corrosion resistance.

To guarantee ready availability of this important engineering metal, TMCA has opened in Toronto, Ohio, the world's first plant designed and instrumented solely for rolling and forging titanium to aircraft quality standards.

This plant guarantees more titanium at better delivery dates than ever recorded in the history of titanium metal.

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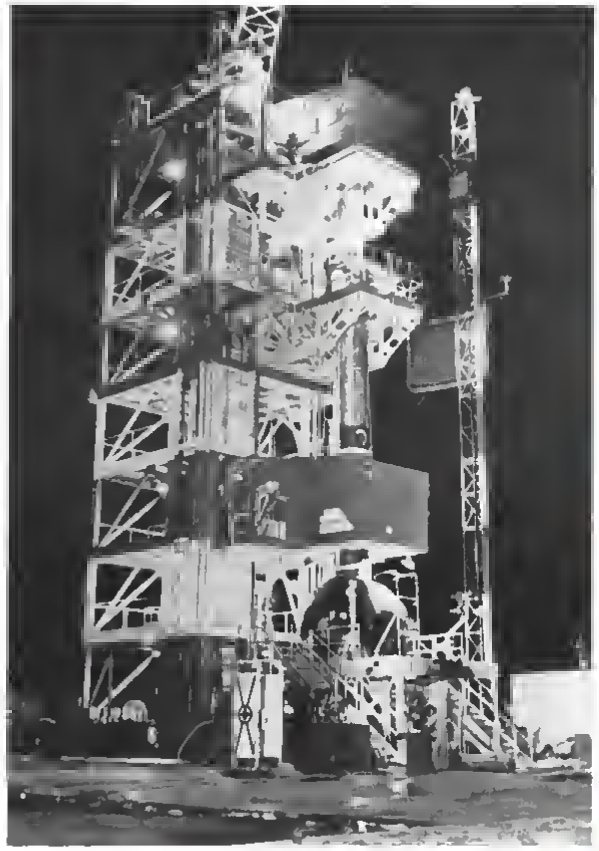
tion with an accuracy of within 5%. It has sometimes been done within 2% on the 10,000 ft. now operating. Water braking is programmed by installing masonite dams in the water tank with a standard spacing of 10 ft.

Varying Depths

The compartments thus created can be filled to varying depths so that the fixed, wedge shaped brake scoop under the sled displaces water at a different rate in each compartment. The scoop will cut through the masonite dams easily without any effect on the run. Though drag on the scoop will obviously be a step function, the inertia of the sled will smooth out the deceleration curve acting on the test specimen. When the step from one compartment to the next is too steep to be smoothed in this manner, it is possible to jury rig dams between the standard positions to get intermediate braking values.

Evaluation of data requires accurate knowledge and control of speed. To this end, magnitude, onset rate and duration of thrust are controlled by varying the number, size and firing sequence of booster rockets. The number of boosters can be from one to 18. Largest on hand is the 60,000 lb. thrust Megaboom. Before firing, solid propellant boosters are temperature conditioned in



Vanguard Prepared for Firing

Launch crew services Vanguard rocket during cold windy spell at Cape Canaveral. Hemispherical shelter has been erected around the base of the rocket to facilitate work in that area. Firing was postponed because of trouble in the second stage.

a special building at the head of the track to minimize uncontrolled changes in thrust due to variations in propellant temperature. Performance figures of most solid boosters are accurate to within 10% and can be brought to about 3% by tight quality control and temperature conditioning. One big liquid propellant booster is on hand and another is on order. Track engineers recommend them only for burning times exceeding 10 sec. and projects involving 20 or more runs. Available booster is a liquid oxygen-alcohol engine with preset thrust ranging from 35,000 lb. to 50,000 lb. and acceleration of between 4 and 11Gs. Burning time is up to 4.5 sec. and maximum payload is 1,200 lb.

Booster Inventory

To prevent delays in track scheduling, the center keeps an inventory of boosters available for the use of contractors and project groups from other military organizations. The track user must then purchase replacements for his boosters and turn them over to the center to keep the inventory up.

Need for exact knowledge of speed is answered by a light source photo cell head on the right forward skipper. The source and the cell pass on opposite sides of interrupter plates spaced at 13 ft. intervals along the track. Pulses generated by interruption of the light beam are telemetered to the data collection center in the midway house. A digitizer there checks the taped pulse rate against real time pulses switched into the circuit by the firing signal for a measure of velocity. At several points along the track, a 15 ft. alloy bar with coded interrupter blade patterns indicates position at a given time, making it possible to compute an average speed for checking against the regular velocity measurement in case the light photo head begins jumping interrupter blades.

The data collection center in the big concrete midway house is equipped to receive information from the sled on 16 FM-FM and 32 Pulse Code Modulated telemetering channels. When using all channels, the PCM telemetry circuit will handle 10 bits per second on each channel and has a sampling rate of 750 cps. To measure a fast changing function, it may be desirable to increase the sampling rate by combining channels and to bring the rate up to 24,000 cps. Analog transducer output is digitized aboard the sled for transmission to the data center by the PCM system. System is capable of an accuracy of 99.8%. The FM-FM circuits handle data in analog form with a frequency response up to 3 kc. and overall accuracy better than 94%.

High speed data recording camera pads are posted 1,000 ft. to the right of the track, at 500 ft. intervals. An

ordinary run probably will see cameras installed in 18 of the 70 positions. Slightly further from the track, there are three camera towers from which documentary footage may be taken. Ample permanent wiring runs to all camera sites to provide power, communications and timing. This includes coaxial cable for television cameras. Extra pairs are run alongside the track foundation so that track engineers can hook in special pick-ups for track parameters.

Conditions within the midway house telemetry center are carefully controlled to minimize interference from any source. Two 40-ton air conditioners pressurize the building to 1 psi over the outside atmosphere to prevent the entrance of dust. Air drawn through the conditioners is washed and humidity is adjusted to a controlled value. Temperature is held at 73F.

There are no windows in the building and a wire mesh is imbedded in the walls to reflect stray radio frequencies that might introduce noise in the telemetry equipment. A mesh counterpoise beneath the surrounding asphalt ramp extends 500 ft. from the edge of the building and serves the same purpose. The roof of the midway building is designed to the same stress levels as the floors to accommodate radar sets, if these are deemed necessary.

Welded Rail

The track is made of 171 lb. per yard extruded crane rail. It is cut in 39 ft. lengths as it emerges from the extrusion mill and the segments are marked to indicate the sequence. When they arrive at the track, the segments are welded back together in the mill sequence to form 10,000 ft. lengths. To cope with the problem of thermal expansion in a rail that long, one end of a section is tied firmly to the foundation at the head of the track and pneumatic jacks are used to stretch the rail five feet per mile, which make the length equivalent to that of a free rail at 120F. The downtrack end of the rail then is tied to the foundation in its new position and welded to the uptrack end of the next segment. The stretching and tying procedure is repeated on that segment and each succeeding one.

Adjustable tie downs are spaced at 52-in. intervals to prevent buckling at temperatures above 120F. The adjustable mounts make it possible to align the track to an accuracy of .005 in. A misalignment by this amount at the point of maximum deviation makes a curve with a radius of one mile. The need for tolerances this fine is evident from the fact that at Mach 4, a turn with a radius of one mile produces a lateral acceleration of 130Gs and even at Mach 2 it amounts to 30Gs. In practice, the lateral acceleration due to a misalignment of this order of a sled is much less because the slippers riding on the track have a finite length which causes them to move along a flatter arc than that of the track. Slipper length is maximized to cash in on this, but it is limited by the fact that increasing the length increases the rate at which the slipper is destroyed by heat.

Track alignment is measured every hour of the day and before and after every firing. When more is known about this particular installation, the frequency of readings may be reduced. The 52 in. long alignment jig is so accurate that it can measure the deflection of an 8-ft. iron pipe caused by the pressure of a finger.

Friction Heating

Much has been learned about the effects of friction between slipper and track but experts here concede that there still is more which is unknown. The effect of friction heating upon the track is slight. Melting apparently occurs to a depth of about one molecule, leaving the surface cold after the passage of the sled. The slipper, however, appears to burn like paper. Readings from thermocouples mounted on slippers indicate that they should melt but there is no real certainty about how they are being destroyed. Lubricants, especially dry ones can do much to reduce the effect of friction. Even a fine mill scale will lower it appreciably. A dry lubricant highly regarded here is lead sulfide paint applied to the track. Another technique is to cut slots in the slipper pads and fill them with silver solder or similar material with low melting and evaporation points. The slipper then rides on a cushion of vaporized metal. The Holloman track may go to this technique for runs in which the vibration level is high. Extreme vibration increases the rate at which metal is carried away from the slipper pad and can result in a three quarter inch, 200C lateral slap. Holloman engineers also are watching experiments at Edwards AFB in which water is squirted directly on the track.

Production of Regulus II Begins on Quantity Basis

Chance Vought will begin quantity production of the Regulus II guided missile under $26 million Navy contract with provisions for spare parts and special support equipment estimated at an additional $7.5 million. Navy is building three submarines, the nuclear USS Halibut and the conventionally-powered USS Grayback and USS Growler, to fire the missile.

Conventional submarines now in the fleet would require conversion before they could carry the Regulus II.

Problem-Solving Products from Republic

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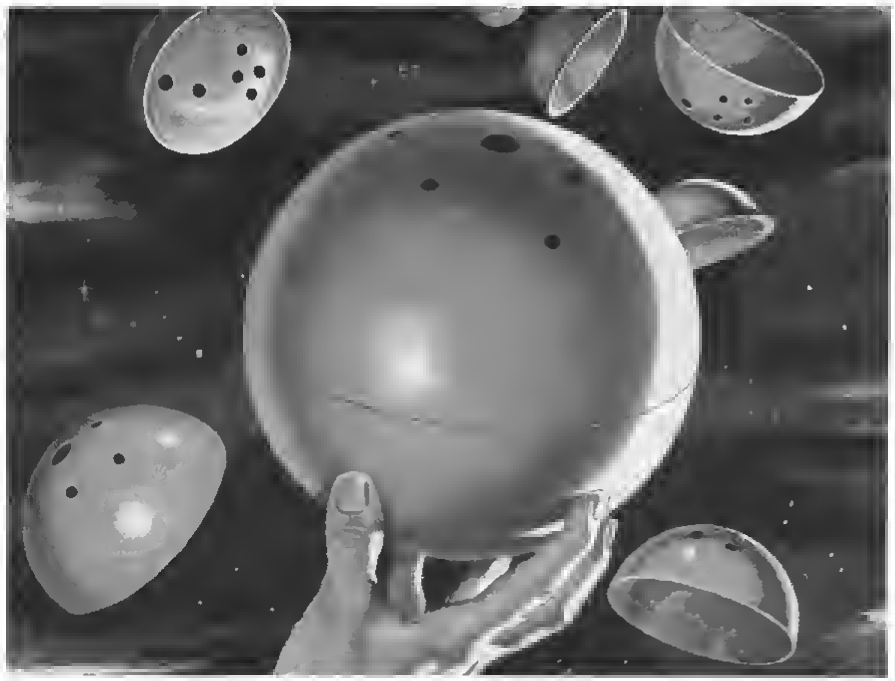

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Alloy Products Corporation, Waukesha, Wisconsin, utilizes three major advantages of commercially pure Republic Titanium, Type RS-70, in meeting these requirements:

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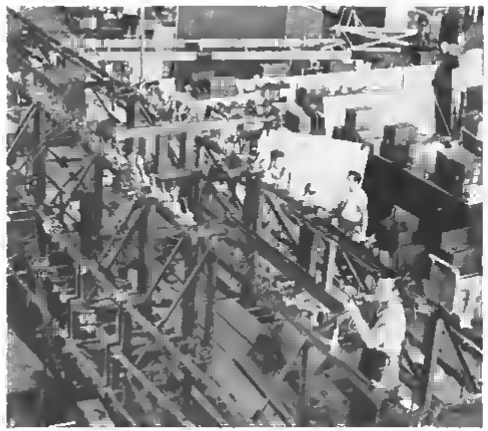
The entire fabricating operation is performed without difficulty and with little change in procedure as compared to other materials. Fabricating steps include drawing, trimming, piercing, extruding, and welding.

Does this application of Republic Titanium generate an idea for your product that needs to be strong, lightweight and corrosion-resistant? Republic Metallurgists are ready to help you apply titanium's advantages now. This service is confidential and without obligation. Mail coupon today for more information.



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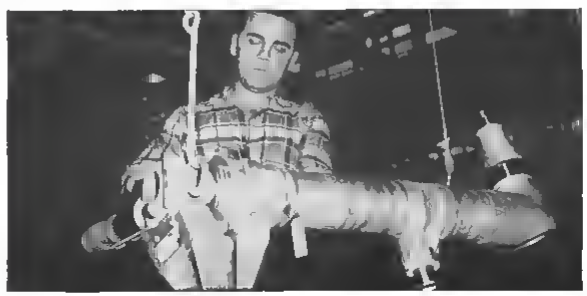

MAXIMUM RESISTANCE TO FATIGUE, strength and toughness are provided by Republic Alloy Steel in landing-gear struts of North American's F-100. The struts are made by Bendix Aviation Corporation. Bendix and Republic metallurgists, working closely with North American engineers, developed a new grade of alloy steel to meet exacting requirements of the strut's inner and outer cylinders. It has a strength range of 220,000—240,000 psi and maintains this great strength at wide temperature extremes. Republic Alloy Metallurgists are available to help with your projects.

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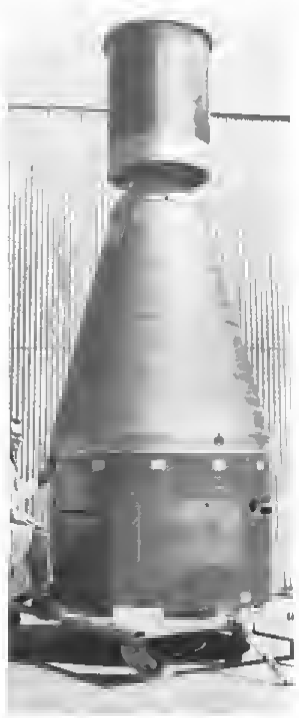
NOSE SECTION (picture at right) for the first stage of Army's Jupiter-C missile that carried the Explorer Earth satellite into orbit dwarfs technician at Reynolds Metals Co. plant at Sheffield, Ala., where the sections are built. Spin launcher held second and third stages in bucket-like container at the top, shown in detail in above photo. The fourth stage containing the Explorer satellite was mounted on top of this. Device gave the last three stages a rotating motion for stability. The brackets at left above are part of the spin launcher's packing case.



Army's Jupiter-C Spin Launcher Adapted for Earth Satellite

REYNOLDS METALS technician inspects spin launcher at Sheffield assembly line.

JUPITER-C first stage nose cone moves down production line. Missile incorporates an inertial guidance system.

American Astronautical Society Meeting:

Simulated Manned Missile Flights Facilitate Evaluation of Pilot Role

New York—There is no doubt that the human brain is the most advanced computer available on a pound-for-pound basis, even taking into account the surrounding human structure. The big question now is whether the brain and body can function efficiently or at all under the extreme conditions of speed, acceleration and altitude that will be encountered in tomorrow's weapon systems. Specifically: 'Can man fly a missile?"

To find out, North American Aviation ran a series of tests in which pilots "flew" the X-10 and XSM-64. These were test vehicles used in the development of the Navaho system. The X-10 was powered to supersonic speeds by a turbojet and was capable of making conventional takeoffs and landings. The XSM-64, still undergoing flight tests, is ramjet-powered and is boosted from a near-vertical attitude by a rocket engine. Recovery of the XSM-64 is essentially the same as for the X-10 but is more complicated because of the ramjet vehicle's greater speed and altitude.

Piloted Missile

The pilots flew the missiles either from the control console of an analog computer or from the cockpit of specially rigged F-86Ds which were set up to simulate the flight of both missiles.

The two methods of simulation were synthesized into a composite control system.

The results of these tests, as detailed at a recent American Astronautical Society meeting by William L. Morris and Richard C. Kachler, indicated a generally high human capability in the handling and control of the missiles used in the study. Among the results and conclusions listed by the authors:

- **In only one crash** was pilot error even partly responsible.
- **About 25%** of the successful flights were saved at some critical control stage by pilot action.
- It was found that the X-10 could be landed under airborne control.
- Pilots were able to control the X-10 in regard to attaining the proper Mach number at the proper altitude and at the proper geographical locations in order to execute a vertical dive in.
- In the XSM-64, on the other hand, pilots were unable to sense malfunctions in the boost control system in time to make corrections.
- It was found that pilots could maintain Mach number in a ramjet vehicle in case the automatic Mach control system failed.
- Also, the pilots were able to control the XSM-64 during the approach phase with sufficient accuracy up to the time of automatic landing flare if accurate radar information was available.

In addition, said the authors, the tests showed that it was advisable to display time during the boost phase so that the control pilots could monitor time-sequenced events. To do this, a single-hand clock which made one revolution during the boost period was used. It is also desirable to display normal acceleration. This gives the pilots a more rapid indication of control system malfunction than do related parameters.

Human Judgment

Will man be able to fly tomorrow's space vehicles? There are still too many questions that must be answered before this one. But this much is certain. At the present state of the art, electronic units are still no substitute for human judgment. And these tests have shown, the speakers asserted, that a human pilot, given the proper controls, can measurably increase the probability of a successful flight.

System capable of telemetering a TV picture of significant events during the flight of a supersonic missile was reported by D. Hockham and J. O. Taylor of Lockheed's Missile Systems Division. Lockheed study indicates system could be used to transmit on-the-spot TV picture of stage separation, motor burning, vehicle motions and other important information over distances of 1,000 mi.

TV Camera

Proposed system would operate at approximately 450 mc, employ frequency modulation, require a channel bandwidth of at least 10 mc. Using single TV camera mounted on missile, such a system could provide resolution of 485 lines per frame, with frame rate of 24 per second. (Home TV has a resolution of 525 lines per frame.) Two TV cameras could be used in combination with time-division multiplexing to provide 250-line resolution at the same frame rate. Lockheed's study indicates:

For an antenna, missile TV telemetry system could use an isolated section of the nose as a resonant cavity to excite the entire missile skin. Ground-based antenna would be designed to track the missile by radar.

McGuire: *"When you're comparing electronic systems, you've got to look at the manufacturer's know-how and service facilities, too."*

"Our IBM 705 was paying for itself in a few weeks—and we had just scratched the surface..."

—John S. Woodbridge, Comptroller, Pan American World Airways, Inc., in an exclusive interview

ACCOUNTING ENTERS THE JET AGE: THE PAN AM STORY

How can you find the best way of bringing the benefits of electronic data processing to your company? What does "electronics" require in the way of planning and personnel? What can a company expect in actual savings and benefits? You'll find the answers in the remarkable achievement of Pan American World Airways, the transportation industry's pioneer in electronic data processing. In this recorded discussion, John S. Woodbridge, Comptroller, and James McGuire, Assistant Comptroller—the men who spearheaded Pan Am's project—reveal the problems and practical solutions to a successful data processing program.

Q. Let's start at the beginning. Why did you turn to high-speed electronics?

A. Frankly, with our explosive increase in business, we had come so far and grown so fast that the saturation point for our existing accounting and record-keeping systems had been reached. At that point—it was early in 1954—we began exploring electronics seriously.

Q. Were there many problems at that stage?

A. Some, but we did know pretty well where we wanted to use electronics. And we actually had a good part of the analysis done before we started. We've had continuing cyclical reviews of our methods for many years now. When you've got those studies behind you, half your evaluation work for electronics is done.

Q. How did you go about finding a system best suited to your requirements?

A. We compared five different systems. *Expandability* was typical of the features we looked for. We felt the system we chose should be able to encompass further company growth with the simple addition of extra units. The IBM 705 was just such a system.

Q. Were there other factors—beyond features of the system itself—that affected your choice?

A. Yes, of course. Aside from satisfying ourselves that the equipment would meet our needs, we looked into such things as the educational and service programs of the manufacturer. How well could he train our people? How well-trained were his own people? We looked into the extent and nature of his systems experience and know-how. IBM scored highly in all these areas.

Q. After you chose the IBM 705, what was the next step?

A. Programming. You may be surprised to learn we did this job ourselves—with IBM's help, of course. We felt on safer ground training some of our own people than in hiring outside programmers who would first have to be taught our business. Experience has borne out the wisdom of this approach. But here's a key point—we took only our top people—our department heads—for the job. There were about ten altogether. They went to IBM program school for four weeks, and then went to work. In effect, we locked them up and said, "Don't come out until the job is done."

Q. How did they work out?

A. Very well. Our programs—in fact the entire operation—went off without any major hitches. That was in May, 1956. Since then, there has been continued growth in the company and in accounting volume, yet we haven't had to enlarge the department.

Q. Are there further savings and benefits you can point to?

A. Plenty. We're now handling—on just one-and-a-half shifts—a number of major applications, ranging from payroll through inventory analysis to "paper jet flying." In a typical area—monthly passenger accounting and control—we cut a 4,000-hour job down to 140 hours. And right off the bat, we picked up $350,000 a year in interest by our ability to process bills for the airline clearing houses in two days instead of in two weeks.

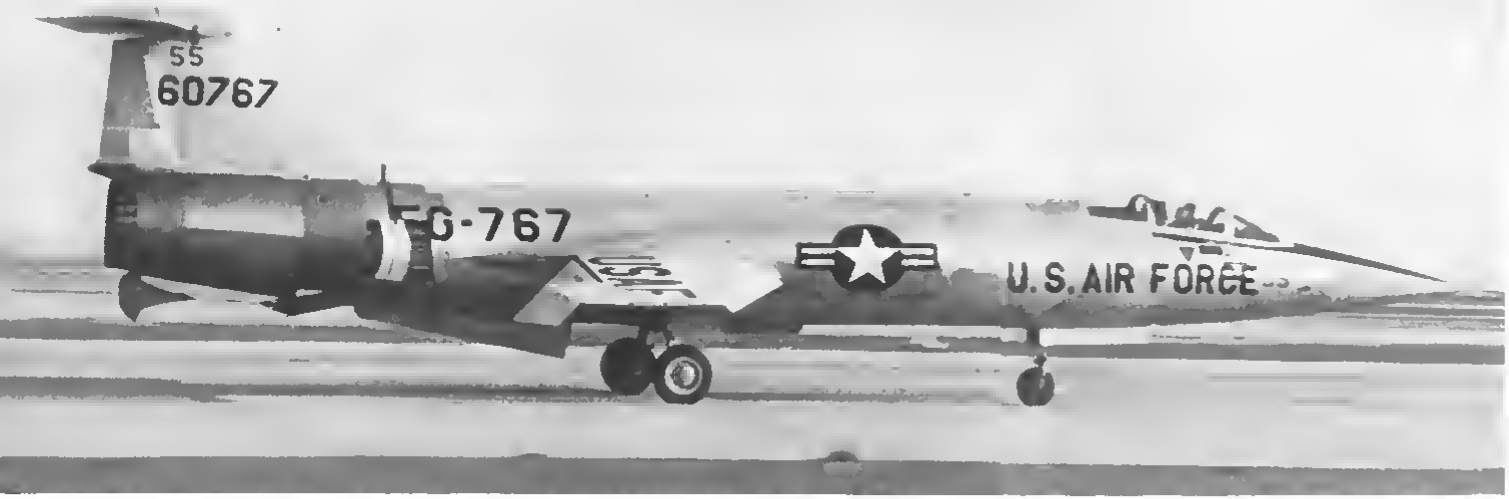
Woodbridge: *"It's much more than just an accounting machine. It's a management machine."*

Q. You mentioned applications other than accounting. What about these?

A. They're interesting by-products of our electronic accounting equipment, and they don't take up much machine time . . . yet they have tremendous potential for us. Take this "paper jet" application we spoke of. Our engineers feed into the 705 such data as distances between cities, runway lengths, and weather factors. Against this we project the characteristics of new jet aircraft, and the 705 produces—among other vital data—the cost per ton-mile for each type of plane under different cruising conditions. We can know in advance which of these aircraft will pay off best for us. The 705 does in one-half hour what would have taken months and months of manual calculation.

Q. You installed this IBM 705 for accounting. How did you get into these other areas?

A. That's just the point. This 705 is much more than an accounting machine. It's a management machine. All you have to do is expose your people to the potential of electronic data processing—and before you know it, you have more good ideas for using it to improve internal operations than you ever thought possible.



TOUCHING down, Lockheed F-104A pops small pilot chute that pulls out larger slow-down chute. Leading, trailing edge flaps extend . . . and speed brakes open (under forward edge of vertical stabilizer).

USAF F-104 Completes Test Program, Enters Squadron Use

F-104 is about to become operational at Air Defense Command's Hamilton AFB, Calif.

By Irving Stone

Burbank—Currently coming into the homestretch of its test phase Lockheed Aircraft Corp.'s T-104 Starfighter is a combat aircraft design which encompasses the capabilities of a lightweight air superiority fighter, a ground support plane and an interceptor.

Lockheed will not reveal performance figures but AVIATION WEEK has learned that while the plane's present speed is in the general area of Mach 2 (1,325 mph.) it has exceeded this figure on many occasions and that production planes have regularly exceeded a recent F-101 Voodoo official speed record of 1,207 mph. in production test flights.

It probably is the most completely wrung out combat plane ever funneled into U.S. military inventory. More than 60 F-104s are involved in an exhaustive proving program in which Air Force, Lockheed and General Electric Co., builder of the J79 power plant, are participating.

The J79 incorporates a 17 stage compressor coupled to a three stage turbine for a thrust output in the 10,000 lb. category. General Electric will not comment, but AVIATION WEEK has learned that the J79-3A engine in the F-104A will put out about 15,000 lb. thrust with afterburner, while the J79-7 engine, slated for F-104 growth, will have improved specific fuel consumption, a 2-in. increase in turbine diameter and will top the total J79-3A thrust figure by about 500 lb.

Lockheed's contract from the Air Force, in March, 1953, was to build two prototypes. Key considerations in the basic design included development of specific data on how to create a 3%-thick wing for the configuration and method of designing a horizontal tail for mounting on top of a vertical tail and still avoiding flutter. These factors and other critical items were evaluated in flight with models mounted on 5-in. high velocity aircraft rockets (HVAR) which carried gun cameras on their noses and pointed back to the model air foils. This work was a continuation of studies which were begun before award of the F-104 contract.

Characteristics of the F-104 design as finally evolved, include the following:

- **Straight wing**, which results in lower gross weight and higher performance for the fighter mission in the Mach 1.5 to 3 range than the delta configuration, according to Lockheed engineers.

Problem of attaining high lift with the very thin (3%) wing was resolved by fitting the leading edge with a flap and curving down the trailing edge. This feature, combined with boundary layer control (blowing) system, made possible the use of a very small wing area in comparison to the gross weight.

For lateral stability, 10 deg. of cathedral was incorporated because, without this droop, the high tail would intro-

AFT views shows variable nozzle tailpipe, indicates there is annular space around tailpipe for secondary airflow.

F-104A air intake details. Opening below "U.S." is a cannon port for General Electric Vulcan.

duce adverse roll with rudder deflection.

One of the problems of the very thin straight wing was to obtain adequate stiffness. Solution was use of relatively heavy skin over spars and ribs, with special attention to structure continuity to avoid multiplicity of skin joints, since too many of these junctions would lower structural stiffness.

Sharp wing leading edge and control surface leading and trailing edges, are machined from solid stock.

Because wings are thin, hence relatively light, they are bolted to fuselage intake ducts by simple flanged fittings. Fuselage rings in this area thus become the wing carry through structure to save critical fuselage space.

Wing Fuel Lines

Thin wing also posed a difficult problem for conducting fuel from pylon and tiptanks. Fuel lines, pumps and other fuel system units had to be specially planned and integrated with the shallow structure as it was designed, instead of designing the structure first and making fuel installations conform.

High strength 75ST aluminum was used extensively in wing (and fuselage). Although operating in a high temperature regime, heat is not applied long enough to warrant any appreciable use of stainless steel or titanium alloys. Thus, use of comparatively heavy 75ST members promoted structural rigidity.

• All flying horizontal tail on top of vertical stabilizer is similar to wing in configuration and thickness with single piece skin giving maximum strength and stiffness. High tail gives pitch-up in the super-stall region at angle of attack beyond maximum lift, but the configuration was adopted because of very favorable control and stability throughout the flight range. To keep the plane from ever entering the super-stall region, Lockheed incorporated an automatic pitch-up control which has proven very successful in flight tests. Vanes on fuselage nose measure angle of attack. When specific angle is encountered, stick shake results and if pilot persists in pulling to a higher angle, booster is actuated to give nose down movement.

Subsonically, stick shake is not required because normal warning comes from wing buffeting.

In addition there is a rate gyro and if pilot pulls up too fast or too far, forward movement of the stick results which is essentially artificial stability control.

• Vertical stabilizer also is constructed of heavy skin in conjunction with spars and ribs. High horizontal tail at one end of the vertical stabilizer and fuselage area below vertical stabilizer provides an end-plate effect which almost doubles the efficiency of the vertical tail, giving very good directional sta-

ALTITUDE vs. speed envelope for jet fighters indicates expanded test range.

hility, a prime factor in avoiding roll coupling.

Booster Units

Booster power units for the movable horizontal tail are housed in the vertical stabilizer. These boosters, and those used for aileron actuation, are specially designed to fit space and load requirements. Thus, for aileron actuation, there are 10 small booster cylinders contained in a shallow box in trailing edge of each wing, instead of a fewer number of larger cylinders. The larger cylinders could not be accommodated in the airfoil's trailing edge, also they might have allowed twisting of the aileron because of increased spacing.

• **Fuselage, in comparison with wing,** is relatively large but has a high fineness ratio for low drag. Long fuselage was required to accommodate all internal fuel and practically all equipment which could not be accommodated in the thin wing. This puts space in the fuselage at a premium because engine with afterburner takes up more than half of fuselage length.

For maximum strength within a minimum configuration of shell, Lockheed used many forgings—rings, bulkheads and more heavily loaded members—where conventional built-up structure would normally be used. Zero-draft forgings contributed to minimum weight and cut manufacturing costs associated with whittling material.

• **Landing gear,** which also could not be accommodated in wing, is designed to fit into side of fuselage. To blend with space limitations in the body, landing gear required unusual hinging and swiveling arrangement. Gear is a long configuration with relatively short deflection, originally designed to give good clearance between ground and belly so that atomic bombs could be carried externally. Long gear also permits external stores under wing without danger of hitting rear of store in high nose position.

• **Air induction** and exhaust is a very advanced system. Lockheed will reveal no details, but AVIATION WEEK has learned that the exhaust feature is to create a bypass (secondary) flow to give supersonic nozzle effect at engine exhaust.

Intake duct is symmetrically placed with respect to top and bottom of fuselage to give low drag and maximum duct efficiency. Ducting is fabricated from integrally stiffened aluminum alloy panels. These tubular form units are slit lengthwise and unwrapped into flat sheets which are chemically milled to required section, then stretch-formed. This type of makeup gives duct smoothness and rigidity.

• **Sighting system** was proposed and developed by Lockheed in conjunction with Radio Corp. of America, General Electric and Aerojet-General. Radar weighs about half of any installation with comparable range, Lockheed claims. Complete radar system is contained in area 2½ ft. in diameter and 2¼ ft. long in conical nose radome which slides forward on internal rails, exposing the equipment. All test points and adjustments are located on periphery of radar housing for easy access in preflight maintenance. Each chassis of the system is shaped like a triangular segment that can be quickly disconnected from main frame. Two men can remove the complete system and replace it in approximately 10 min.

• **Cockpit** is comparatively simple. It is

fitted with "peek and panic" panel which has single master warning light and printing below which spells out the specific difficulty. This installation also is featured on Lockheed's new Jetstar, Electra transport and T2V trainer.

Cockpit visibility over the nose is good, since straight wing allows low angles of attack.

Ejection Seat

Downward ejection seat has been installed for simplicity and safety in high speed escape. Because canopy is not tied in with downward ejection sequence it is jettisonable by manual release of latches for wind to blow off. This type of installation eliminated appreciable complexity and weight.

• Single 20-mm. cannon has multiple barrels and fires up to 6,000 rounds per minute, equivalent to five single 20 mm. M24 machine cannons. Cannon is used for air-to-air attack and air-to-ground firing against trucks and other targets.

Other forms of armament can be readily carried. F-104 is capable of carrying air-to-air guided missiles such as Navy infrared guided Sidewinder.

• Electronics compartment is located directly behind cockpit, extends for approximately five feet to the rear. Compartment is shaped like round top trunk with access provided by hinged door on top. To stay within space and weight limits of the design, electronic gear like much of the other equipment, was specially packaged for weight saving of 20% and space saving of 50%. Each electronic box is a repackaged version of a standard item of government equipment identical except in shape and, in some cases, power supply.

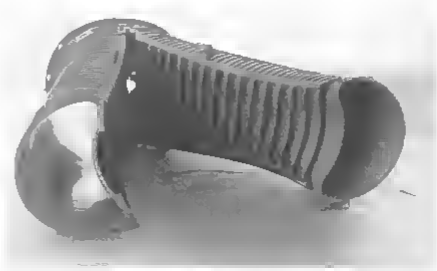
'Jeep-Can' Box

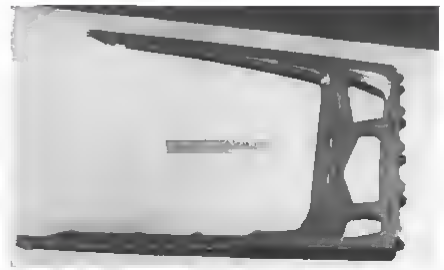
Repackaged box is known as the "jeep-can" because of resemblance to gas container used for the military jeep; has same shape as electronics compartment. Boxes are similar to each other in height and depth but can vary in width. Upper portion of box outboard face is sloped inward and carries test points and adjustments behind a hinged flap. Each unit has a self-test feature for rapid "go, no go" check in plane. Internal arrangement of the jeep-can configuration is modular wherever possible. Rack is shock-mounted on frame.

By relatively simple modification of equipment F-104 can be adapted to handle the variety of fighter aircraft assignments.

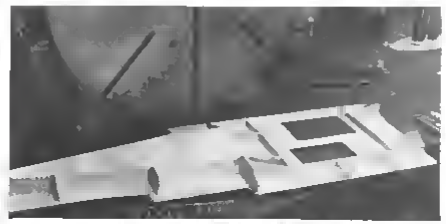
• Hydraulic system is another example of installation refinement for easy access, maintenance and service. Components are installed on inside of swing-down door and fully exposed with door opening.

• Boundary layer control, which reduces





ENGINE intake duct, at left, is placed on top and bottom of F-104 fuselage to give low drag with maximum efficiency. Tubular form units are fabricated from integrally stiffened aluminum alloy panels. At right precision casting is held to .015 in. tolerance.



MACHINED forging at left is still in finishing process. Forging is about 50 in. long and has web thickness of 0.12 in. Photo at right shows F-104 avionics compartment fitted with "jeep can" boxes to save weight. Each unit has built-in checkout features.

plane's landing speed by about 20 mph., cuts landing distance by almost one-fourth, uses turbojet compressor high velocity air piped into the wing, from where it is fed through slotted tube out over upper surface of trailing edge wing flap. Flow valve begins to open automatically as flap reaches the 15 deg. mark. Full open valve position is reached when flap is extended to 45 deg. F-104 is first production fighter to use boundary layer control.

Production Studies

Much of the overall F-104 refinement stems from producibility studies which, under Air Force contract, were conducted concurrently with F-104 preliminary design. Compiled by production engineering department under supervision of George W. Papen, these studies comprised an extensive analysis of alternate methods of building the F-104. Cost of investigation and evaluation of materials and methods totaled about $400,000. It is estimated that, as a result of these studies, approximately $13,500 per plane would be saved on a 1,000 plane basis. For 500 planes this figure would change roughly to $16,000 per plane. Saving is less for larger quantity production because of more favorable learning curve.

Producibility investigation included broad limits. Some items which were seriously considered, but finally rejected, including cast truss type core assembly for the wing, top and bottom forged wing skins and complete cast wing which initially appeared feasible because of the small airfoil.

Final analysis brought decision to use a large number of no-draft forgings, precision castings and specialized compression forming techniques for sheet metal. Precision forgings, which require machining only on mating surfaces, total about 75 and vary from 1 to 25 lb.

No press larger than a 15,000-ton unit has been required for these forgings. About 40 castings in aluminum and steel have been used, weighing up to 13 lb., and produced by shell, permanent mold and centrifugal methods.

Sheet Metal Forming

Compression-forming has been used for sheet metal parts to obtain accuracy comparable to that in precision forgings and castings. Compression formed parts include major members such as spars, ribs and longerons.

Extrusions have been used largely to obtain maximum smoothness, accuracy and reduction of number of fasteners.

When forging and extrusion design thinness limits were exceeded, chemical milling was specified to further reduce these sections.

Thick skins require only step-milling on conventional planer type equipment.

Considerable research and development went into canopy contact forming to retain high optical qualities usually important at very high aircraft speeds.

Considerable work was done on fabrication and heat treatment of precipitation hardening of stainless steel alloys, since this was in the early stage of development of these materials.

Actuating system cylinders were designed in aluminum alloy and wear surfaces hard anodized by refinement of the process. This saved weight by elimination of steel units.

For F-104 high-heat low-alloy steel parts, Lockheed developed vacuum metalizing techniques to replace plating solutions with which hydrogen embrittlement is associated. These techniques were applied to landing gear, control surface actuators and fittings. Steel parts in production now have 260,000 psi ultimate tensile strength. Particular attention was paid to development of subassemblies which could be completely checked on the bench prior to installation. This reduced final assembly checkout time and made sizable reduction in amount of in-ship search for errors and correction.

Thorough Test

While the F-104 will have been more thoroughly shaken down than any other combat plane before entering service, this extensive proving has tended to delay introduction of the fighter into operational status. One of the prime

factors causing the testing stretchout is voiced by W. L. (Doc) Howland, Lockheed's assistant chief flight test engineer. Back in 1949 he points out speed range over which military planes were tested was about 5 to 1. This applied, for example, to the F-80, which had touchdown of about 100 mph and top speed of about 500 mph in level flight. For the F-104 this ratio has climbed to about 10 to 1. Operational ceilings also have soared.

Significance in these tremendous increases is that there is a larger range over which to maintain adequate stability and control, maneuverability and engine operation. Howland points out, with the higher speed and altitude limits increasing.

More than 60 planes in the test program are scattered in Air Force base locations such as Eglin, Edwards, Holloman, Hamilton, Wright-Patterson and at Palmdale, Ft. Worth and Sacramento. Lockheed pilots have chalked up substantially more than 1,500 hr. of flight test time on F-104As since Feb. 17, 1956, when Herman (Fish) Salmon, Lockheed's chief engineering test pilot, first flew this model. This amount has been supplied by Air Force testing and by General Electric engine flight tests in three F-104s, so that total time for the F-104s now is in excess of 3,000 hr. and encompasses more than 4,500 flights. Before the F-104A was flown, Lockheed had accumulated approximately 250 hr. in the XF-104 fitted with Wright J65.

Test Program

Of the 18 F-104As which Lockheed has been testing at Palmdale, 11 are being used to check out fire control, air conditioning, air loads, armament, stability and control, special stores (two F-104s being used) and powerplant (four F-104s). In addition, three F-104B two-place versions are involved. Two have been put through preliminary testing in preparation for Air Force testing for Phase II, while third plane will be used by Lockheed for specification testing.

Highlights of Lockheed F-104 test program include:

- **Trading speed for altitude has been extensively explored.** About 75 to 100 flights have been made in this regime, which have demonstrated adequate controllability, established minimum pressures for engine and afterburner operation, investigated spin entries from vertical zooms. When airspeed was bled off, pro-spin controls were deliberately applied to try to make plane spin without success, indicating that zoom can be made safely down to very low airspeeds. Normally, from top of zoom, with no speed, plane falls off and enters dive.
- **Extensive spin tests,** flown by Lock-

Etendard IV Makes Steep Climb

Steep climb capability of French Dassault Etendard IV, a light tactical fighter, is shown in this picture of takeoff from French airfield. Powered by Snecma Atar E turbojet engine, Etendard IV can take off and land in 1,600 ft. Engine develops 8,000 lb. thrust, driving airplane to reported Mach 1 above 25,000 ft. Aircraft is redesignation of Mystere 24.

lheed's J. F. Holliman, have been completed (AW Jan. 13, p. 23). F-104 was taken to altitudes between 36,000 and 39,000 ft., stalled 36 times, and no spin encountered. In an attempt to spin coming out of a turn, Starfighter snap-rolled, but would not spin. "A pilot has to go through intense buffet, stick shake, lateral instability, then apply cross control after pitching up to spin the F-104," Holliman says. "It is virtually impossible to achieve that set of circumstances."

• **Flutter tests on wing and tail** have been completed. In this investigation Lockheed developed a new technique, approved by the Air Force, for determining flutter margin in flight. Considered a major development, method measures damping in flight to be sure oscillations are damped out under all conditions.

Procedure permitted, with structural modification, raising of flutter onset above placard speed of the plane considered especially significant with very thin surfaces.

After flutter tests, a large portion of the aluminum alloy vertical fin was changed to steel for greater rigidity to obtain adequate flutter margin.

• **Introduction of damping** for oscillation about all three axes was one of the problems associated with F-104 speeds. To improve damping, plane has been fitted with stabilization augmenters for the three axes to improve the weapon as a gun platform. Flight tests were conducted to determine optimum sensitivity and phase shift for these three controls under conditions ranging from stall to maximum speed. Amount of damping throughout the speed range now provides a gun platform far superior to any previous Lockheed fighter. Stabilization augmentation holds gun sighting to within ½ mil against Air Force requirement of five mils.

• **In roll coupling tests**, now completed, Lockheed pilots determined amount of aileron throw compatible with all flight regimes. There has never been a single instance of autorotation due to roll coupling, according to Howland. To increase roll coupling margin and improve directional stability, ventral fin has been installed on underside of aft fuselage.

• **Thermal effects** on structure have been thoroughly checked. (It is not uncommon for paint to blister at F-104 speeds.)

Wing was instrumented with both temperature and strain gauges to insure that structural strength was adequate at elevated temperatures encountered which, incidentally, were found to be somewhat lower than theoretical values used in designing the structure.

Temperatures have aggravated difficulty of air conditioning and cooling of electronic equipment. Some modification of air conditioning system has been made as result of the flight tests.

• **Pressure recovery** of the air inlet system has been thoroughly checked both in the tunnel and in flight tests at speeds and altitudes far above those previously encountered in fighter aircraft.

• **Stability and control** investigations are essentially completed, including pitch up checks.

• **Control system** on XF-104 required some debugging, and it was necessary to install a rudder lock to make rudder irreversible through neutral. This feature is carried over to F-104A.

• **Transonic regime** is traversed without trim change. Aerodynamically, this is considered a noteworthy achievement, attributable to the thin airfoil section and location of horizontal tail.

• **Speed brakes** can be extended up to maximum speed with no longitudinal trim change necessary.

• **Plane has been dead-sticked** successfully on landing and glide characteristics are reported to be comparable to other Century Series aircraft. Glide ratio is about 10 to 1 in clean configuration.

• **Basic fire control** testing is essentially completed. Improvements fed in by Lockheed and Radio Corporation of America relating to range and accuracy are now being checked.

• **Antenna pattern** tests and radio noise

tests also have been completed.

Concurrently with Lockheed and Air Force F-104 testing, General Electric is conducting an independent J79 powerplant evaluation at Edwards AFB in three F-104As, an F-11F-1F and in F-101. These extensive proving trials encompass the broad operational envelopes of speed and altitude, include the following evaluations:

- **Reliability** and endurance trials. Endurance tests are accelerated runs, aimed at chalking up 1,000 hr. in 10 months. This phase is scheduled for completion in April.
- **Main engine controls**, for determination of optimum fuel schedules.
- **Afterburner configuration** and control tests which have led to redesign of fuel control for greater simplification and afterburner improvement for more stability and easier relights.
- **Main engine relight**. Additional sparkplug has been added to improve this feature. Power input to the ignition boxes also has been boosted.
- **Development of pilot techniques** for operating the engine in the air.
- **Operation of engine** beyond limits of operational envelope by running the powerplant to slow, too fast and at too high an altitude to determine safety at these end points. Engine stall problem was encountered at maximum speed and corrected by change in inlet duct by Lockheed and by General Electric's change in fuel control to increase the stall margin at this condition.
- **Effect on engine** stall line when variable stator vanes are too far open or too far closed has been established. This procedure determined optimum stator positions, also demonstrated what happened when stators were too slow to close. Actuating system has been refined for adequate closing rate.
- **Automatic control** has been built into exhaust nozzle to maintain constant exhaust temperature when operating either at full military or afterburner condition, regardless of speed or altitude. This control also schedules optimum area of nozzle for cruise and idle conditions.

Engine Test

As of Jan. 1, General Electric test pilots at Edwards AFB had chalked up 116 flight hours on instrumented F-104A, 300 on accelerated service F-104A, 75 flight hr. (150 engine flight hours) on McDonnell F-101 and 200 flight hours on Douglas XF4D. Grumman F11F-1F has recently entered this General Electric test program. Tempo of company testing is indicated by 40 flights made in five days with two F-104As, for total time of 50 hr.

Design changes indicated by flight tests have been checked out in large number of "house" engines at General Electric's Evendale, Ohio, plant for

Trident II .04 to Attempt Altitude Record

First picture of Sud-Aviation's Trident II .04 shows aircraft equipped with Turbomeca Gabizo jet engines (2,420 lb. thrust each) which have replaced Dassault-built Viper wingtip jets used on Trident prototypes. Aircraft will shortly try for altitude record (AW Feb. 3, p. 69). Two chamber rocket in tail is retained, producing combined rocket-turbojet thrust ratio of slightly less than 1:4. Note topside speed brakes extended

proof testing before flight of the changed article.

J79 powerplant weighs considerably under 3,200 lb. Length is 204.5 in., compressor frame diameter is about 33 in.

Most significant innovation in the engine is the use of the variable geometry compressor, in which pitch settings of first six stator stages and the inlet guide vane are automatically controlled as a function of engine rotating speed, aircraft flight speed, and compressor inlet temperature, to give optimum engine performance under all conditions of starting, acceleration, cruise and high power. This feature permits high performance with a single compressor and turbine rotor, with requirement for only three main shaft bearings, for simplicity and light weight.

Forward section of compressor, including front frame and compressor stator casing, is magnesium alloy. Balance of engine is steel. Compressor rotor consists of thin web disks with conventional dovetail plates bolted along the rims for maximum stiffness and minimum weight and eliminating need for central shaft through compressor.

Pressure Ratio

General Electric will not comment on engine's pressure ratio, but AVIATION WEEK has learned that figure is approximately 12:1.

Combustion chamber is cannular type. Three-stage turbine rotor construction is similar to compressor rotor makeup, with conical shaft for coupling to compressor section.

Power for accessories is taken from forward end of compressor radially downward to one gear case, then aft along shaft to another gear case at rear location. The two gear cases are placed in tandem to cut down on frontal area of engine.

Control system is conventional except for arrangement required for operation of variable stators.

Main control elements include main fuel control, afterburner fuel control and variable stator control. Action of these control systems is integrated so that pilot has only one lever to manipulate.

Lubrication system for engine is integral, and oil cooling also is self-contained, utilizing high pressure engine fuel as the coolant.

Engine Development

Like the F-104, General Electric's J79 has had a relatively fast development and very intensive proving program. Start of design was Jan. 1, 1953. First engine was tested on June 8, 1954, first test flight (in B-45 flying test bed) was on May 10, 1955, 50-hr. preliminary flight rating test (after total of 1,639 factory test hours) on Aug. 25, 1955. First test flight as a prime mover (in modified Douglas XF4D) occurred on Dec. 8, 1955. Delivery of first engine to Lockheed for F-104A was on Dec. 31, 1955, first flight in F-104A followed on Feb. 17, 1956. GE's 150-hr. qualification test, after total of 6,366 factory test hours, was on Aug. 11, 1956. In December 1956 GE completed delivery of its first batch of 100 production engines.

Running time on J79 engines up to early January, 1958, totaled 38,825 hr. This includes 19,836 hr. of development test time, 2,000 hr. field time (such as in NACA and ARDC tunnels), 5,150 hr. of flight time (includes Air Force, Lockheed, General Electric, Grumman on F11F-1F, Convair on B-58 and Navy on Regulus II), 2,575 hr. of ground runs connected with flight operations, and 9,264 hr. of production ground test time.

Design Origins

Roots of the big jump represented by F-104 technology go back to after World War II, when Lockheed set about to find a replacement for its F-80. Company participated in a competition on heavy penetration fighters, which included McDonnell XF-88, North American XF-93 and Lockheed XF-90. All of these designs were rejected by Air Force after evaluation because specifications did not reach far enough and powerplants weren't available.

Lockheed wanted to stay in the fighter business but it was obvious that supersonic configuration was called for. First step was to take the XF-90 and refine it to meet this requirement. Basic development work was done, with Lockheed's own funds, on a very thin wing which became the basis for the F-104 airfoil. This was followed by

Is it possible to build a **MAN?**

Theoretically, yes," said the scientist. "Or a reasonably remarkable imitation—a kind of mechanical analogue. Call it a habit machine, a mechanism operating according to the laws of the conditioned reflex."

You mean that you could actually build a mechanical mind? One that would exhibit emotions —such as love, fear, anger, loyalty?

"We're doing something like that now in advanced missile development, the scientist replied. In a limited, highly specialized way, of course."

"Take the 'pilot' that is being developed for the big long-range missile. *He* has a wonderful memory, and can solve many complex navigational problems in a flash. *He* loves perfection, and actually becomes highly excited when *he* gets off course. *He's* a tough-skinned character, impervious to the cold at several hundred miles altitude and the incredible heat at re-entry. And *his* loyalty is heroic. *His* life is a single mission, the mission *his* whole life, and maybe ours, too. *He's* a pretty important *fellow*."

What about the complete man made Man? What would that entail?

"A mechanism the size of the capitol in Washington, and the best scientific resources in the world. But it could be done. You see, it's only a question of how physical matter is organized. As a great biophysicist explained, 'If material is organized in a certain way, it will walk like a man. If it is organized in another way, it will fly like a missile.'"

Still, wouldn't there be something missing in the complete man made Man—something very important?

"Yes," said the scientist. A soul.

MARTIN

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design of the Lockheed X-7 ramjet test vehicle where again, very thin wing and tail surfaces were exploited. Considerable flight data was amassed on wing aeroelasticity and aerodynamic characteristics which were investigated into regimes which caused breakup of a number of thin wings in the air.

Next phase in progression to F-104 was when Lockheed proposed its Model L-205 (about 1950) in a competition which was won by Convair with the F-102. Lockheed's L-205 configuration was in the 30,000 to 35,000 lb. gross category and featured overhead intake duct.

Day Superiority

At about this time the Korean conflict got under way. Russian MiG-15 was outperforming Allied aircraft, particularly in ceiling and high altitude maneuverability. Feeling among United Nations pilots was that first-line MiG-15 pilots were being trained against our first line planes. Observation was that when MiG pilots got into trouble to end the action they would climb above 45,000 ft., which was about the practical limit for the F-86. Feeling was that there was a need for a day superiority fighter in the weight class of the MiG-15.

North American Aviation was ready to go forward with the F-100 design, a relatively heavy plane with a lot of Korean experience funneled into it. Lockheed had nothing on its drawing boards to meet the requirement it felt had been generated by the Korean conflict.

Studies were started on a range of configurations spanning gross weights from 12,000 to 40,000 lb.

Initial studies investigated the importance of stripping a fighter. This involved such factors as removing half the armament, half of instrumentation, removal of safety devices such as dual boosters, and omission of anti-icing equipment, pilot cooling, ejection seat and even radio equipment. Without these items, design resulted in a configuration with a gross of 28,000 lb. compared to a 32,000 lb. gross for an unstripped version. It was realized that this stripping went too far but the scheme was projected to see what the overall effect would be. High speed didn't change appreciably, acceleration was improved (from Mach 1.83 to 1.90).

Clarence L. (Kelly) Johnson, Lockheed vice president-engineering and research, who was then spearheading the project as chief research engineer, concluded that degree of stripping considered was not worth performance advantages gained.

It also was realized that fuel weight in a supersonic fighter including that for afterburning would be a critical

factor For example, total fuel load for a given time of fighting for F-86B was about 30% of takeoff weight, while for supersonic fighter it would be boosted to 38%. To offset this 8% boost it was concluded that light weight was of top importance, and that utilization of space would be critical because of the relatively small structure which minimum weight would dictate

Because flight time would be another critical factor in a high-Mach supersonic plane, Lockheed investigated all the conditions affecting fuel reserve These included such items as drag resulting from battle damage, flight at too low an altitude, use of afterburner in excess of fighting time and extended cruise as a result of chasing enemy too far

Also investigated was effect of gross weight of such conditions as change in combat radius, armament weight variation and landing ground roll

Mass of analyses finally led to Lockheed's proposal for the F-104 early in 1953 Although it was realized that the plane could not initially fly with General Electric's J79 turbojet, the configuration was designed around this powerplant XF-104 flew with Wright Aeronautical's J65 and was piloted first by A W (Tony) Levier, Lockheed director of flight operations who was then chief engineering test pilot

MOUNT FUJIYAMA provides background for C-130 Hercules transport which will take over Japan intra-theater airlift.

Hercules Replacing C-119 in Japan Airlift

Langley AFB, Va.—Eight Lockheed C-130 Hercules transports will start airlift missions in mid-March for Pacific Air Command in Japan, as part of program to replace Fairchild C-119s now in use there

Tactical Air Command said the C-130s will be deployed to Ashiya, Japan, from Ninth Air Force's 463rd Troop Carrier Wing at Ardmore AFB, Okla Others will be sent later for intra-theater airlift duty

Hercules has a cargo capacity of about 35,000 lb., approximately 20,000 lb more than the C-119 Aircraft began TAC operational service in 1956 Squadrons slated for C-130s are 815th and 817th Troop Carrier Squadrons at Ashiya, and 21st Troop Carrier Squadron at Tachikawa

Recently, two C-130s en route to Japan were diverted at Guam to join Pacific search for downed Boeing WB-50 weather plane Planes cruised for 8½ hr on two or three four Allison turboprop engines, flying at 1,000 ft and under 200 mph in a 15,000 sq mi search

Lockheed Aircraft Corp Assistant Chief Pilot Don Mills, Atlanta, Ga., said by using only two engines, the C-130s decreased fuel consumption by 40% He said aircraft had about 4½ tons of fuel remaining after landing at Guam Normally, C-130 cruises at 30,000 ft at better than 350 mph

Aircraft Parts Firm Opens Indiana Plant

The H & B American Machine Co Inc., producer of aircraft structural parts and airframe components, has opened a $5 million facility at Indianapolis, Ind., to manufacture nine airframe components for the Convair B-58 bomber, along with parts for the Boeing B-52, Convair F-106, Chance Vought F8U-1 and other military and commercial aircraft The 110,000 sq ft plant will precision-machine wing spars, bulkheads and other structural parts forged in alloy-steel, aluminum and titanium.

Initial employment is 420 persons with an ultimate expansion to 750 planned

Production work is described as tracer controlled contoured machining Machine operators follow the lines and surfaces of a template with a small stylus which hydraulically or electronically causes the machine to mill, bore or drill a forging into the exact shape of the pattern This process, developed since World War II, is becoming increasingly important to airframe manufacturers who rely more on large aluminum forgings

Tracer control machines are equipped to handle these large pieces One wing spar mill has a 90 ft horizontal travel. Forgings before machining, frequently weigh as much as 2,000 lb The sculpturing process, however, will machine away 80% of original metal Despite size of work, most specifications permit variances of no more than .002 in

Advanced Bomarc

Two new defensive missile projects are being undertaken at Boeing Airplane Co. in addition to IM-99 Bomarc First of new weapons is an advanced model of present Bomarc Second is an anti-ballistic system.

Performance differences between present Bomarc and advanced Bomarc flight vehicles will be substantial, but ground alerting, guidance and logistical portions of the advanced Bomarc system would be virtually identical with present Bomarc for standardization of ground equipment for the two weapons Advanced Bomarc also will have more range than present IM-99, and Boeing intends to replace liquid fuel rocket presently used in the Bomarc with a solid propellant motor.

Advanced Bomarc is well along in development stage, under sponsorship of USAF, and would be able to seek out and destroy aircraft and missiles at distances presently associated with manned interceptors Identical in external appearance to present Bomarc, new missile will fly as pilotless interceptor with nuclear warhead.

Anti-intercontinental ballistic missile weapon is described as a substantial research project undertaken by Boeing in conjunction with other firms in the missile field. Object of program is development of weapon systems capable of detecting intercepting and destroying ICBMs so far above the Earth that atomic fallout would not be a problem.

YJ69 Raises Thrust Of TT-1 Navy Trainer

Dallas—Performance of TT-1 Navy trainer has been improved by installation of YJ69-T-25 engine Temco Aircraft Corp. is currently flight testing the new engine in the TT-1 prototype to measure performance gains

New Continental engine produces 1,025 lb thrust about 10% more than the thrust of the earlier version of the J69 originally used in the TT-1

Flight tests have not been completed, but calculations indicate that the new J69 will increase the TT-1's sea level rate of climb to 2,090 fpm and raise the service ceiling from 32,200 ft to about 35,200 ft. Top speed at 15,000 ft will be increased to 315 kt. Takeoff distance will be shortened by 350 ft, and takeoff distance over a 50 ft obstacle will drop 484 ft to a 2,513 ft run

Institute of the Aeronautical Sciences Meeting:

Army Wants VTOL-STOL Design Having High Payload, Simplicity

New York—Major objective of U.S Army's VTOL-STOL program is development of a vehicle minus the complexity of the helicopter and having a higher payload-to-weight ratio, Donald M Thompson, director of aviation research and development, U S Army Transportation Corps, told IAS members

In this era of pioneering basic configurations, few guidelines are available to manufacturers on design details which embrace tilting wing, deflected slipstream and ducted fan configurations Results of tests with these early vehicles will primarily be used to develop flight handling and design requirements leading to later purchase of hardware

In discussion with one contractor, Thompson learned that if propeller shafts were interconnected, payload would only be some 10% of the aircraft's weight, if unconnected the ratio would rise to some 25%

Current Army proposals for aircraft have interconnected propellers, he noted

U S. Marine Corps' ultimate goal is complete level-attitude VTOL capability for assault transport, observation and ground support fighter and attack aircraft, reported Hugo G Sheridan, head of the airplane design section, Research Division, BuAer Research Division has defined VTOL and STOL characteristics as follows VTOL is the capability of taking off and landing with zero ground roll and clear a 50 ft obstacle within 50 ft. STOL is the ability

Century Series Portrait

Six USAF Century Series fighters are shown in Palmdale, Calif. Clockwise from the top they are the Convair F-102, Lockheed F-104, Republic F-105, Convair F-106, North American F-100 and the McDonnell F-101. The F-105 in the photo is an early model and has squared-off engine air inlets in contrast to the supersonic internal type inlet on the production aircraft The F-101 Voodoo shown is a newer model, wing sweep has been sharply increased just outboard of the engine inlets

to take off and land over the same obstacle in less than 50 ft.

For open sea operation, Navy is studying STOL application to sea planes having a capability of taking off in distances under 350 ft., although up to 500 ft. are considered acceptable, Sheridan noted. Operation in a Sea State Four would be a must with Sea State Five capability being highly desirable. Sea State Four is defined as a rough sea with 5 ft. to 8 ft. waves. Sea State Five as a rough sea with 8 ft. to 12 ft. waves.

An interesting concept that may offer several military applications is the so called "ground effect flight vechicle," Sheridan reported. This type depends entirely upon the augmenting lift received by discharging a jet stream through an annular nozzle while the aircraft is at low level.

National Advisory Committee for Aeronautics is devoting its major efforts in V/STOL/STOL aircraft to general purpose transport designs, reported Charles H. Zimmerman, Langley Field Laboratory. In addition, the agency is setting up second stage flight test programs for Army-Navy-Office of Naval Research projects. Ryan X-13 is being given an extensive full-scale flight test program by NACA at the High Speed Flight Station. Ryan X-14 deflected jet stream test bed is being turned over to Ames Laboratory to study flight and handling at low and zero speeds.

NACA is also setting up flight programs for the armed services on the new Doak X-16, which features ducted fans at the wingtips. NACA is planning additional work with models to measure forces and moments on propellers and shrouds of this type of configuration through 0-90 deg. angle of attack range.

Major problems foreseen in V/TOL aircraft operation include:

- **Erosion of soil** under the aircraft when near the ground, recirculating dirt, debris and exhaust gases into the engines, propellers and fans and blocking the pilot's vision.
- **Ground interference effects** on lift, drag and moment characteristics of most V/TOL/STOL configurations when hovering or flying at low speeds near the ground. Both types of STOL configurations which appear to have greatest potential, interest—deflected slipstream and jet-augmented flap—are plagued with serious losses in lift when near the ground, Zimmerman noted. Same problem applied to tilt-wing designs when operated STOL, he said.

Spin Characteristics

Chance Vought studies of the spin characteristics of modern fighters were detailed in a paper by Mark H. Clarkson. Current aircraft tend to enter flat spins and some speculation has implied that this type of autorotation was entered from a banked attitude. This grew out of the conventional explanation of spinning in which the autorotating wings provide the driving force. The explanation is not valid however, when the fuselage remains level.

Chance Vought reached the conclusion that although the bank angle was a factor affecting the severity of a flat spin, it was not the cause of autorotation. Flow separation around the fuselage nose during yawing motions starts the flat spin and the wings had a corrective effect according to the studies. Separation around the nose—and therefore the flat spins—is sensitive to surface roughness, Reynold's number and the cross-sectional fuselage shape.

These conclusions by Chance Vought agree closely with NACA studies of the same problem.

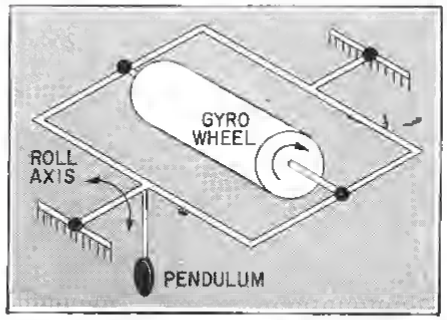
Aluminum Alloy

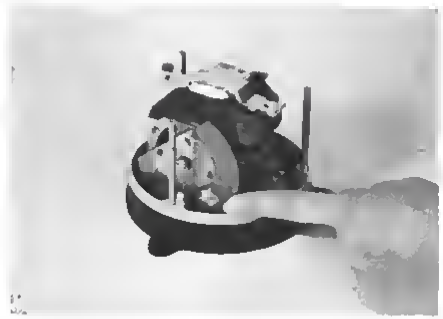
Tendences to use lower strength aluminum alloy (2024) in modern aircraft merely to escape the fatigue problem of higher strength alloy (7075) was discussed and deplored by C. R. Smith of Convair. He cited instances where basic design changes would give higher strength alloy adequate structural life and afford significant weight savings.

Main design problem pointed out by Smith was the loss of fatigue life with small amounts of overload. He suggested that thinning out the understructure would prevent the loosing of rivets in parts vulnerable to fatigue cracking. On the Convair 880 this policy was followed and in any place that the first row of rivets engaged a splice the understructure is never more than half of the thickness of the part being spliced. Bending in the first row of rivets was also reduced by designing to only 50% of the full rivet shear strength, to raise fatigue life.

In new aircraft the use of laminated structure so that the first row of rivets engages the first laminate only can raise joint fatigue life 10 times according to Mr. Smith. On older aircraft the fatigue cracking problem can be eased by using edge-driven rivets along existing joints. These additional edge driven rivets take part of the bending load off the first row of rivets. As the additional rivets can resist no shear load their bending load does not contribute to fatigue damage. Such joints have a life five to 10 times longer than the older type, according to the Convair studies.

Smith pointed out that lower strength alloy definitely has its place in an aircraft structure (e.g., where stiffness rather than strength is the prime consideration) but he felt that much more research was needed in the design of fatigue-resistant structures so that the full weight saving potential of higher strength alloy could be realized.





AUTOMATIC turn compensation for vertical gyros is provided by new rate gyro pendulum developed by Norden-Ketay. Centrifugal forces acting on pendulum during a turn are canceled out by precision torques developed by rate gyro as aircraft turns.

13-lb. Vertical Gyro Offsets Turn Error

By Philip J. Klass

Commack, N. Y.—Novel technique which practically eliminates vertical gyro turn-error that usually results from extensive airplane turning or maneuvers has been developed here by Precision Components Division of Norden-Ketay Corp.

Small 3 lb. roll-axis erection control can be used with most existing vertical gyros to provide automatic turn error compensation. A complete vertical gyro system with turn compensation is available at a weight of 13 lb. including erection amplifiers.

Turn error results from the fact that most vertical gyros employ a pendulum, or equivalent, to prevent the gyro axis from drifting off its vertical reference. Gyro spin axis is electrically slaved to keep it aligned with the average (long term) position of the pendulum which indicates direction of local gravity (vertical) under smooth air, non-maneuvering flight conditions. Two pendulums are usually employed, one for pitch axis erection, the other for roll axis erection.

Slaving Rate

Slaving rate of gyro spin axis to pendulum(s) is sufficiently slow that momentary deflections of the pendulum(s) from vertical caused by rough air do not displace the gyro spin axis from vertical.

During a turn or other maneuver, however the airplane and its roll-axis pendulum are subjected to continuous centrifugal acceleration which deflects pendulum from vertical for duration of the turn.

If airplane remains in turn for an extended period, vertical gyro spin axis moves to align itself with the false vertical position of the pendulum, producing what is commonly called "turn-error,"—a false horizon indication.

Past Approaches

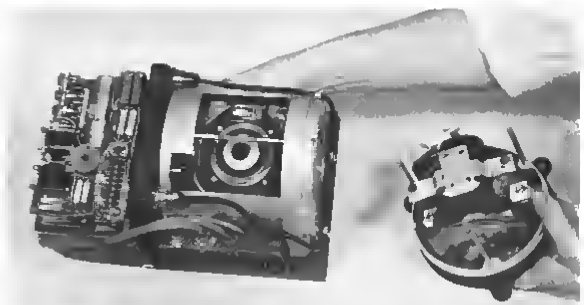
Gyro designers in the past have employed several techniques to minimize or partially compensate for this turn error. Simplest technique is to tilt the complete gyro and pendulum forward slightly and thus is used in many horizon indicators aboard moderate-speed aircraft which do not normally engage in extended maneuvers.

Another approach is to automatically disconnect the gyro from its roll-axis pendulum whenever airplane turn rate exceeds a predetermined value.

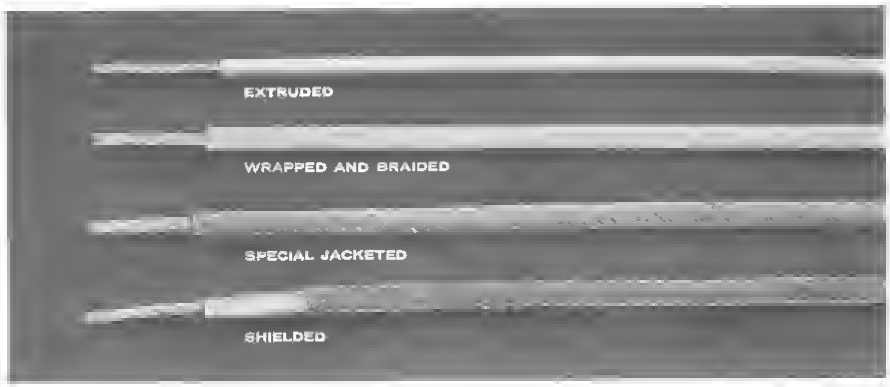
The gyro then operates without roll-axis erection for duration of turn, with the idea that drift errors will be smaller than those resulting from accelerations on the pendulum if it were left in operation.

Norden-Ketay uses a more ingenious approach to solving the problem by mounting the roll-axis pendulum on a separate, small single-axis-of-freedom gyro. This turn compensation gyro is gimbaled so that it can move only about airplane's roll axis and is installed so that the gyro spin axis is parallel to airplane wings. (See sketch.) Unit resembles a conventional rate gyro except that the gyro element is centered and restrained in its movement by pendulosity instead of by springs.

When installed in an airplane any turning motion will produce a precession torque on the gyro which seeks to



COMPLETE turn-compensated vertical gyro system for flight control weighs 13 lbs.



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					CONDUCTOR	INSULATION			
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	S	500°F CABLE	PE 150 S(S)	600	SILVER PLTD COPPER	EXTRUDED TEFLON			HIGH TEMPERATURE – COLORS AVAILABLE
MIL-W 16878/4A	EE	500°F CABLE	PE 700-SS(B)	1600	SILVER PLTD COPPER	TEFLON TAPE	GLASS BRAID	TEFLON ENAMEL (COLORS AVAILABLE)	HIGH VOLTAGE – HIGH TEMP – ULTRA HI FREQ
	EE	500°F CABLE	PE 150 EE(E)	1200	SILVER PLTD COPPER	EXTRUDED TEFLON		(COLORS AVAILABLE)	HIGH VOLTAGE – HIGH TEMP – ULTRA HI FREQ
MIL W 7139A	TESLON	500°F	PE 400	500	SILVER PLTD COPPER	GLASS REINFORCED TEFLON TAPES AND FILMS			SINGLE AND MULTIPLE CONDUCTORS–COLORS
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	7MM	500°F CABLE	5MM Z R		PLTD COPPER	TEFLON	GLASS BRA D	TEFLON ENAMEL	HIGH TENSION IGNITION COPPER
	–	500°F CABLE	PE ALT 5MM S-A		7 X 4 S P C STEEL	TEFLON	GLASS BRA D	TEFLON ENAMEL	LOW TENSION IGNITION – ROPE LAY
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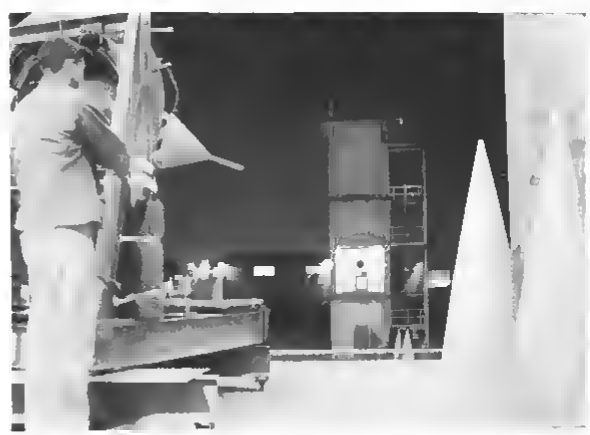
Radome Test Facilitiy

Nation s largest private remforced plastic radome test facility, capable of handling 18 radomes simultaneously from three-story control center operating with six radially dispersed testing towers, has been opened by Zenith Plastics Co , Gardena, Calif , subsidiary of Minnesota Mining & Manufacturing Co New facility and another Zenith range can handle radomes ranging in size from 5 in. to 40 ft in diameter, company says. Radomes are tested for transmission efficiency, reflectivity, beam bending and pattern distortion Radome materials can be tested for dielectric constant and loss tangent



move it (and the attached pendulum) in a direction opposite to that in which the pendulum seeks to move due to centrifugal forces.

By proper choice of pendulum weight length and the angular momentum of the gyro wheel (mass and rotational speed), it is possible to end up with a device in which the centrifugal forces in the pendulum during a turn exactly cancel out gyro precession torque produced during a turn. This ideal balance exists for one particular aircraft speed, specifically ground speed, but this is impossible to know in advance because winds aloft are unpredictable when the equipment is designed.

For this reason the turn-compensator is designed for the airplane's normal cruise speed, or any special value required for a specific mission. Differences between design and actual airplane speed do not produce serious errors, according to Carl Machover, Norden Ketay application engineer. A 50% variation in airplane speed from the design value produces only half the turn error that would exist without such compensation, Machover says.

Furthermore, it is possible to provide automatic aircraft speed compensation, if required, by varying the angular momentum of the rate gyro wheel proportional to airspeed. This can be accomplished by using a synchronous

gyro motor, powering it from a variable frequency source whose frequency is controlled automatically as a function of airspeed so that motor speed, hence momentum, is proportional to airspeed according to Machover.

Norden-Ketay currently is negotiating with several companies for sale of the turn compensator, consisting of small rate gyro and pendulum, by itself for use with vertical gyros made by other manufacturers. Norden-Ketay's complete vertical gyro system with turn compensation has been evaluated by Air Force at Eglin AFB, also has been sold to one major avionic equipment manufacturer.

Principal characteristics of the system include:

- Free-gyro drift rate: 15 deg./hr.
- Limits of motion: ±85 deg. about pitch axis; unlimited maneuverability about roll axis.
- Erection rates: Roll axis .05 deg./min./deg.; Pitch axis 1.0 deg./min./deg.

Although Norden-Ketay is the only company known to be producing turn compensators of this type, the basic technique of coupling a pendulum to a gyro to compensate for turn accelerations is covered in a patent filed by Elmer Sperry in 1918, issued in 1932, since expired. Sperry patent also refers to possibility of varying gyro wheel speed to compensate for changes in airspeed.

FILTER CENTER

▶ **Masers on the Move**—Problem of ballistic missile detection and early warning will greatly spur application of Masers and similar solid state microwave amplifiers to radar and other detection equipments. Sperry Gyroscope Co., which has named Dr. C. L. Hogan, Harvard Maser expert, to consulting staff of its Microwave Electronics Division, predicts that "we are on the verge of an important breakthrough that may double effectiveness of anti-missile radars and other detection devices." Hughes Aircraft Co., Radio Corporation of America and General Electric Co. are other manufacturers believed to be pushing Masers for radar and detection applications.

▶ **WS-110A to Use Stellar-Inertial Guidance**—North American's new hypersonic chemical bomber reportedly will employ modified version of the stellar-inertial guidance system originally developed by NAA's Autonetics Division for the Navaho long range missile. Combination of two techniques should provide better accuracy than pure-inertial system. International Business Machines Corp., responsible for

the overall bombing-navigation system, will buy Autonetics' stellar-inertial system, turn over complete system to Air Force which will provide as GFE to North American.

▶**Stavid Continues DAMS**—Stavid Engineering, one of three original Phase I (study) contractors for Defensive Anti-Missile System (DAMS), is one of two selected to carry on Phase II of the program. Stavid's associates in the program include Olin Mathieson Chemical Corp., Bausch & Lomb Optical Co. and United Shoe Machinery Co.

▶**Three Military Reactors**—Atomic Energy Commission will negotiate contracts for studies of a mobile nuclear powerplant for military use with three contractors. General Electric, Curtiss-Wright and a team consisting of General Motors Corp. and Nuclear Development Corp. of America. Mobile nuclear powerplant is to be designed to produce 2,000 kw., be extremely light and compact. Studies are expected to take about nine months.

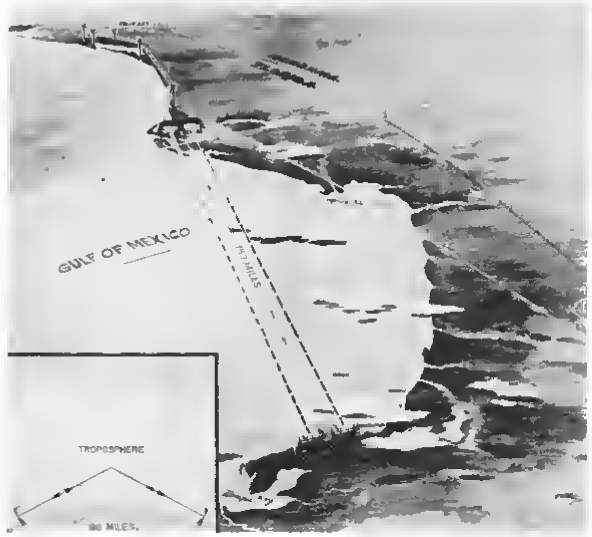
▶**Airline Tube Consumption**—Domestic airlines buy an average of 100 to 200 replacement vacuum tubes per airplane very year, recent AVIATION WEEK survey indicates. Airlines whose fleets are predominantly twin-engine aircraft, particularly DC-3s, average closer to the 100 tubes per airplane figure because of smaller number of avionic equipments employed.

▶**No Popcorn Please**—Recent Air Force-sponsored tests reveal that popcorn is not a good cushioning material for packaging avionic equipment, compared with conventional cushioning agents such as bound hair and cellulose wadding. Report on tests is available from U. S. Department of Commerce, Office of Technical Services, Washington 25, D. C.

Price is $1.00. Ask for PN 131162, "An Evaluation of Popcorn as a Cushioning Material."

▶**Wescon Issues Call**—Persons who would like to present papers at the annual Western Electronic Show & Convention (Wescon), Aug. 19-22, in Los Angeles, should submit 100-word abstracts and either the completed text or detailed summary before May 1. Send all material to Dr. Robert C. Hansen, Microwave Laboratory, Hughes Aircraft Co., Culver City, Calif. (For ideas on how to improve technical papers, see AVIATION WEEK, Jan. 6, p. 76.)

▶**Novel French Transistor**—New type of pentode field-effect transistor which achieves its largest gain-bandwidth product at frequencies between 200 and 500 mc., has been developed by the French Postal Service Research Center. Germanium transistor is etched or otherwise formed into dumbbell shape with indium doping along the "handle" of the dumbbell. New device, called Tecnetron after its inventor, Stanislas Teszner, reportedly has exhibited 22 db gain over a 1.7 mc. bandwidth at 110 mc., a 16 db gain and 6 mc. bandwidth at 200 mc., and a 9 db gain over a 30 mc. bandwidth at 430 mc. French hope to achieve several watts output at 1,000 mc. with new technique.



Scatter for Eglin Range

Tropospheric scatter and five-hop microwave relay system, linking Eglin AFB with Cape San Blas, Fla., for use in connection with Air Force bombing, gunnery range over Gulf of Mexico, will be constructed by Philco Corp. under recently awarded $2 million contract. Dual antennas will be employed to permit simultaneous two-way transmission of telemetering, radar, timing data and voice. Frequency diversity will be used to minimize fading. Microwave relay will operate in 7 kmc. band, scatter link at 2 kmc. Project is scheduled for completion within 18 months.

▶**Navy Seeks Maser Hardware**—Navy Bureau of Aeronautics Avionics Division is in the market to buy a radar, or other equipment, incorporating new Maser (atomic) amplifiers to evaluate applications for the new extremely low noise amplifiers.

▶**Four Billion for Electronics**—Defense spending for military electronics is expected to reach $4 billion in Fiscal 1959, roughly 10% above current year's $3.6 billion, according to estimate by Electronic Industries Assn. The Association figure indicates that 25% of military purchases in Fiscal 1959 will go for electronics.

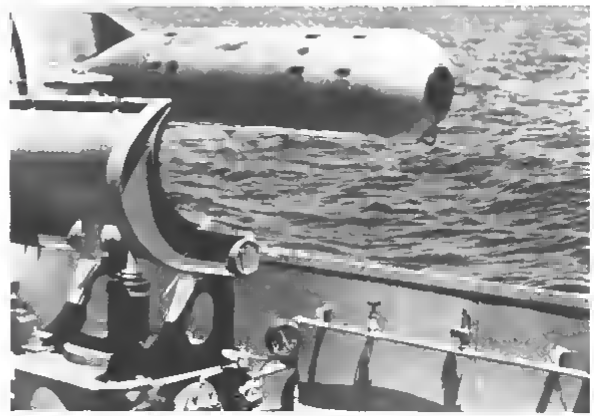
▶**New Annc Spec**—Latest revision to Aeronautical Radio's air traffic control transponder specification (characteristic) No. 532B, is now completed and available.

Arinc's address: 1700 "K" St. N. W., Washington, D. C.

▶**New Professional Group**—Institute of Radio Engineers has formed new professional group on Radio Frequency Interference, chairmanned by H. R. Schwenk, with A. R. Kall as vice chairman. Engineers active in this field who wish to join should write IRE at 1 East 79th St., New York 21, N. Y.

▶**Going up!**—Temperature and radiation goals established by the Air Force for electronic transformers are 500C ambient temperature and intense nuclear radiation for operation in the era of high speed nuclear propelled aircraft and missiles, C. J. Duncoan and M. M. Felger of General Electric Co. told the Winter General Meeting of the American Institute of Electrical Engineers.

Lightweight Torpedo Homes Acoustically



MK. 32, acoustic torpedo, is thrown over ship's side by launching device above. Mk. 43 airborne acoustic torpedo below is suspended from wing of Douglas AD. Wing racks indicate aircraft can carry at least six of the 250 lb. weapons. In bottom photo, Mk. 43 is displayed with drop chute unfurled. Parachute slows descent to prevent damage to acoustic head upon water entry. Weapon is dropped over sub position obtained from radio sonobuoy and magnetic detection gear information.

An acoustic-homing anti-submarine torpedo, the Mk. 43, has been operational with the fleet for over a year, Rear Adm. F. S. Withington, Navy's Bureau of Ordnance Chief, said recently.

The torpedo weighs 250 lb., some 2,000 lb. less than its predecessor and can be released by aircraft or surface vessels. It is 8 ft. long and 10 in. in diameter. When air-dropped, a parachute is utilized to slow its descent, when released from a surface ship, a time-delay is incorporated to allow the launching ship to make its get-away. The weapon's light weight permits launching from helicopters and blimps and allows carrying in multiples by anti-submarine aircraft.

Designed on the principle of acoustic homing rather than that of noise attraction, the battery-powered weapon searches the water at varying depths until it detects its target. It then breaks off the search and pursues the submarine, exploding on impact against the submarine's hull. The cost of the Mk. 43 is negligible in comparison with the $300,000 Betty nuclear depth charge.

Adm. Withington remarked that aircraft can and have returned to carrier decks day and night carrying both weapons.

A larger acoustic homing torpedo, designed specifically for use by surface vessels, the Mk. 32, also was revealed by the Navy. The Mk. 32, like the Mk. 43, does not have to be fired from a torpedo tube, but merely thrown over the side from an open launcher. Also operational, the Mk. 32 undoubtedly carries a greater explosive charge than the smaller Mk. 43.

BOET jet engine silencer units are shown attached to French Dassault Super Mystere. Nose unit is mounted on dolly with full-castering wheels, is rolled in front of engine intake. Exhaust unit weighs 33 tons. It is mounted on three rails and is propelled by electricity

French Build Ground Runup Jet Silencer

Bordeaux-Merignac, France—Semi-mobile jet engine silencer for ground runup was recently tested here on a Super Mystere fighter being built for the French Air Force by Avions Dassault.

Silencer, which includes both intake and exhaust units, was designed by the Boet Co. In recent tests before officials of the French Air Ministry and U. S. and Indian military representatives, the silencer cut the noise level of a Snecma Atar G 10,000 lb. thrust engine operating with afterburner from 154 decibels to 117 decibels, a net reduction of 37.

Sound suppression calculations were based on U. S. methods of aircraft noise level determination, according to Boet.

Quick Attachment

One-and-a-half ton nose silencer is mounted on a dolly with full castering wheels so that it may be rolled into position in front of the plane's air intake.

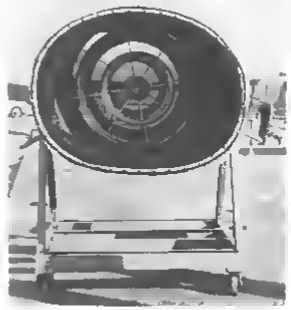
Exhaust suppressor which weighs some 33 tons, is mounted on three rails to facilitate positioning it behind the aircraft's tailpipe. It is driven by an electric motor and is controlled by push buttons. Boet says that four men can attach both units in less than five minutes.

Nose unit inlet faces upward for best possible noise attenuation. Sound reduction is accomplished by perforated baffles arranged in concentric rings within the steel plate outer shell. Glass fiber lip around the connecting end as-

VERTICAL stack behind aircraft tail is cooling air intake duct which draws secondary cooling air into exhaust unit. Air exits with engine exhaust from rear stack (visible in top photo).

QUICK-CLOSING clamshell doors of tailpipe adaptor are shown in open position. Adaptor pivots horizontally to compensate for any pitching of the aircraft due to thrust changes that may occur during engine test. Exhaust unit exterior is constructed of steel plate

NEW AVIATION PRODUCTS



CONCENTRIC sound attenuation rings can be seen in this intake suppressor view. Adaptor lip is made of glass fiber.

sures a good fit with aircraft air intake.

A small rectangular window in the front of the silencer allows mechanics to align the suppressor accurately and also to check for any possible icing conditions.

Exhaust Suppressor

Exhaust unit exterior is also made of steel plate. Interior contains noise dissipating muffler elements, tuned chamber and expansion chamber. Air ducts are lined with glass wool. Secondary cooling air is drawn into an upward-facing stack at the front of the suppressor and exits with engine exhaust from rear, upward facing stack.

Connecting segment at the front of the rear suppressor is hinged vertically and opens clam shell fashion to accept the plane's tailpipe.

The segment is also pivoted horizontally to compensate for pitch of the aircraft resulting from thrust change during engine testing.

Both nose and intake and exhaust silencers can be adapted for use with planes other than the Super Mystere.

Calculator Computes Flight Performance

Small-size aircraft performance calculator that solves the Bregnet range equation and other flight performance parameters has been designed by the General Electric Flight Propulsion Laboratory, Cincinnati, Ohio. Combining logarithmic and altitude tables with slide rule functions, it eliminates reference to other scales and makes transference of data to other computers unnecessary.

Accurate to within 1%, the 6-in. diameter disc is useful for day-to-day calculations and for making quick comparisons.

Helium Regulator

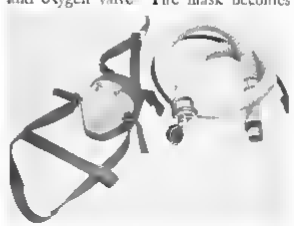
Half-inch poppet single stage helium regulator for missile applications regulates pressures from over 3,000 psi. to 15 psi. with a fine control of plus or minus ½ psi. at extremely low temperatures. Manufacturer says the unit is adaptable to any high pressure application when close tolerance regulation from no flow to high flow conditions is required and that it can be used to regulate any of the exotic fuels.

Regulator measures 6 x 10 x 5 in. and weighs 7 lb. The unit is said to be free of vibration problems and is stressed and counterbalanced for all planes.

The Garrett Corp., AiResearch Division, 402 S. 36th St., Phoenix, Ariz.

Emergency Oxygen Mask

Emergency oxygen crew mask for pressurized aircraft reduces costs by eliminating duplication of breathing tube assemblies. Unit consists of two assemblies: a vinyl plastic oral nasal mask, and a breathing tube with microphone and oxygen valve. The mask becomes



part of the crewman's personal property while the breathing tube remains with the aircraft. One valve is utilized for inhalation and exhalation.

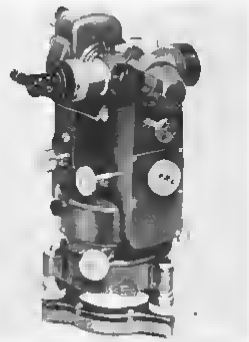
Coil reinforced plastic tubing is available in various colors to harmonize with cockpit interiors and connectors are made to mate with any aircraft oxygen supply system.

Sierra Engineering Co., 123 E. Montecito, Sierra Madre, Calif.

Engineering Theodolite

Microptic Theodolite No. 2, Mark II, is now redesigned for engineering applications, including the alignment and setting up of missile launching platforms, large structures, extrusion presses and rolling mills.

Circle reading eyepiece is placed outside the upright; it can be revolved separately on its own bearings for ease in viewing steep angles. Optical system has been streamlined for greater rigidity and easier service. Bubble controlling set up is totally enclosed within the body of



the upright, making it independent of temperature change and air currents. New short auto collimating eyepiece is now supplied which effectively converts this instrument into a universal auto collimator, providing readings to 1 sec. on horizontal and vertical rotation independent of centering.

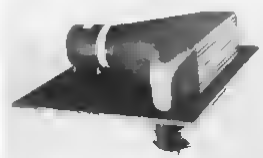
Instrument will also find application in high precision gear testing, checking of accurate indexing motions and in standard and special fixtures and machines.

Engis Equipment Company, Chicago.

Integral Cooler for Avionics

Cooling unit designed to provide a net capacity of 1.5 kw. at 50,000 ft. is mounted on a lightweight structural 20 in. x 24-in. honeycomb base designed as part of the container for the avionics equipment. Container is sealed in a gaseous environment at constant 20 psi. pressure.

Two fans and a heat exchanger make



up the cooler: one fan circulates non-toxic sulfur hexafluoride through the heat exchanger and over the avionics gear, the other fan simultaneously draws cooling ambient air through the heat exchanger crosswise to the gas flow, bringing the gas temperature down to desired limits.

AiResearch Manufacturing Division, Garrett Corp., Los Angeles, Calif.

WHAT'S NEW

Reports Available:

The following reports were sponsored by The Office of Technical Services, United States Department of Commerce, Washington 25, D. C.

Aerodynamic Studies: The Forces Acting on an Air Vehicle—A Review of the Literature—by M. Z. Krzywoblocki, University of Chicago for Wright Air Development Center, U. S. Air Force. May 1957. $2.50, 99 pp. (PB 131385)

Investigation of the Applicability of High Frequency Sound Waves (Ultrasonics) for Cleaning of Precision Parts—by O. E. Mattiat and P. P. Zapponi, Clevite Research Center for Wright Air Development Center, U. S. Air Force. June 1957. $2.00, 76 pp. (PB 131361).

Development of a Nondestructive Test for Evaluation of Adhesion of Electro-Deposits on Steel as in Silver-Plated Aircraft Bearings—by A. L. Walters and S. A. Wenk, Battelle Memorial Institute for Wright Air Development Center, U. S. Air Force. Nov. 1953. $1.75, 65pp. (PB 131226).

Project Vanguard Report No. 21, Minitrack Report No. 1—by R. L. Easton, Naval Research Laboratory, July 1957. $1.00, 31 pp. (PB 131220)

Project Vanguard Report No. 18, Minitrack Report No. 1—Phase Measurement by R. L. Easton, Naval Research Laboratory. July 1957. $1.00, 31 pp. (PB 131220).

Free Radicals as Fuels—by K. Scheller, H. C. Thacher, Jr. and J. A. Bierlein, Wright Air Development Center, U. S. Air Force. Feb. 1957. $.75, 29 pp. (PB 131076)

Investigation of Hydrofluoric Acid as a Corrosion Inhibitor for Fuming Nitric Acids—by M. J. Keeler and F. F. Knoll, Aerojet-General Corp. for Wright Air Development Center, U. S. Air Force. Nov. 1956. $4.50, 180pp. (PB 121864).

Determination of Water in Jet Fuels and Hydrocarbons—by W. D. Garrett and J. A. Krynitsky, Naval Research Laboratory. Sept. 1957. $.50, 16pp. (PB 131247).

Fatigue on a Complex Vigilance Task—by H. J. Jerison and S. Wing. Jan. 1957. $.75, 21pp. (PB 121985)

The Use of Displays Showing Identity Versus No-Identity—by L. M. Schipper, C. L. Kraft, A. T. Smode, and P. M. Fitts, The Ohio State University and The OSU Research Foundation for Wright Air Development Center, U. S. Air Force. Feb. 1957. $.75, 30pp. (PB 131270)

Reaction of Six Radar Air Traffic Controllers to Conference Control of Targets Simulated on a 19-Inch Horizontal Display—by J. C. McGuire and C. L. Kraft, The Ohio State University and OSU Research Foundation. Dec. 1956. $.50. 11pp. (PB 131177)

The Safety of Aircraft Structures—by A. M. Freudenthal for Wright Air Development Center, U. S. Air Force. July 1957. $1.25, 43pp. (PB 131182)

Evaluation of the Engineering Properties of Titanium Carbide Base Cermets—by J. C. Redmond, R. J. Reintgen, J. R. Fenton and M. E. Simon, Kennametal Inc. for Wright Air Development Center, U. S. Air Force. August, 1955. $1.25, 50pp. (PB 131225)

Simple Conversion of an Analytical Balance for Automatically Recording Weight Changes—by C. Campbell & S. Gordon, Picatinny Arsenal, U. S. Army Ordnance Corps. Oct. 1956. $.50, 15pp., (PB 131285)

Fleet-Type Service Planned for Lodestar

By Craig Lewis

San Antonio—Planned maintenance program designed to give executive aircraft operators the advantages of a fleet maintenance operation is under development here by Howard Aero's service division.

Program would put executive aircraft through a maintenance, overhaul and modernization cycle similar to the progressive maintenance technique used by airlines. Howard figures the efficiency and economy of the plan can shave as much as 25% off operators' maintenance costs.

Lockheed Lodestar is the transport Howard will build its program around, although separate plans for other aircraft types may follow in the future. The company is negotiating with operators of 25 to 30 Lodestars and plans to get the program into full operation within a few months.

Want 50 Aircraft

To make the new plan economical, Howard wants to have 50 aircraft in it. The fixed base operator expects to include enough Super Venturas and PV-1s in the Lodestar program to bring it to that level.

Under the planned maintenance program, Howard sets up a schedule covering all maintenance, overhaul and modernization items for an airplane over a five year period. The five year schedule is plotted on the basis of the number of hours flown annually and is tailored to the particular needs of each operator.

At each scheduled inspection period, Howard has a detailed list of items to be covered in that inspection.

Included is a set of specifications for the work to be done, a specific price for each item and the down time involved.

Compared with the usually haphazard scheduling involved in most executive aircraft maintenance, this program can give an operator a much clearer idea of how much his airplane will be tied up during the year and when the work will be done.

Howard can contribute to further time saving by dovetailing modernization and overhaul items which can be done at the same time. Modernization work on the empennage for instance, can be done at the same time as engine changes or overhaul work on the wings so the airplane down time can be reduced.

Since Howard will quote flat prices for the work involved the operator can predict his maintenance cost with considerable accuracy. For instance, on a scheduled engine change, Howard charges $350 for labor on a customer furnished engine. Any extra repairs needed can be done either on a flat rate or a time rate. For a wing overhaul at the 8,000 hr. period, Howard quotes $1,200 and 10 days down time.

Advance Information

With this kind of information available in advance, the operator can forecast how much in both time and money his maintenance, overhaul and modernization will cost him. If he wants to do some work in his own shop, the operator can have his work scheduled so he can do, say, every third inspection at home.

Howard feels that this more sophisticated approach to maintenance is necessary as executive aircraft operations grow into a more mature phase of aviation. The company feels this is a basic problem that fixed-base operators will have to meet as executive operations grow. And this planning has the bonus value of diminishing the chances for misunderstanding between the business flyer and the fixed base operator.

To handle this planned maintenance program, Howard will set up a shop which is separate from its normal service operations. This Lodestar shop will have its own facilities and its own Lodestar specialists. Howard will be able to maintain this kind of operation by scheduling a steady flow of work avoiding the usual peaks and valleys of activity in maintenance shops.

Keeping Lodestar work coming through the shop on a continuing, fairly even level will allow Howard to operate the special facility more efficiently and, therefore, more economically. This means lower costs to the Lodestar operator, and it also means his airplane will be worked on by specialists with equipment specifically developed for Lodestar maintenance.

Lower Parts Cost

Cheaper components can be another advantage to operators doing their maintenance as part of a fleet operation. Fifty Lodestar operators negotiating with an engine supplier are liable to get a better price for a large order than they could get buying independently.

Howard chose to start its program with the Lodestar because there is a large number of such aircraft based at San Antonio, Houston, Dallas, Tulsa, Midland and other points in the Southwest, although the company also ex-

Piaggio Designs Land-Based Gull

First view of new Piaggio P.166 seven place business plane, a redesigned landplane version of company's Gull amphibian. Model depicts many similarities to Gull. Piaggio retained wings, powerplant installation and landing gear, redesigned fuselage and tail. Prototype is starting flight test program for Italian and U. S. CAA Type Certificate. Trecker Aircraft, which has been collaborating with Piaggio on the new plane, will offer P.166 to U. S. and Canadian businessmen as an executive transport.

pects to draw Lodestars from bases outside the Southwest.

Planned maintenance program could as easily be applied to the Beech Super 18, Aero Design and Engineering Co.'s Aero Commander, Douglas DC-3 or other transports used in business flying. Likeliest prospect after the Lodestar program is the Beech.

STEARMAN trainer is one of 11 planes used at Mexico City aviation school.

ICAO Trains Pilots At Mexican School

Mexico City—Aviation throughout Latin America is benefiting from an International Civil Aviation Organization pilot and ground school in Mexico City.

The school, called the International Civil Aviation Training Center, has had 404 graduates since it began operation in 1952. These graduates have strengthened aviation in 16 Latin American nations. Enrollment is growing and right now there are 200 students.

Courses offered include commercial and agricultural piloting, aircraft and engine mechanics, radio mechanics, air traffic control, navigation, meteorology, ground operations, aerodynamics, telecommunications and English.

All courses are taught in Spanish, an important consideration. Before the center existed, Latin Americans usually had to pursue aviation careers in a non-Spanish-speaking country. This presented technical and financial difficulties and frequently braked incipient careers. Nevertheless, courses in English, particularly technical aviation English, are taught at the center to benefit graduates who may be flying to the United States, and to assist them generally in post-graduate studies of aviation manuals.

Standards are rigid. Jerry F. Polivka, director general of the center and a World War II veteran both of the London-based Czech air force and later of the Royal Air Force, estimates a 30% washout of would-be pilots and a 15% washout for students pursuing other careers.

Funds for operation of the school come 35% from ICAO headquarters in Montreal and 65% from the Mexican government. Budget for 1957 was $451,145 and Polivka hopes they'll have the same amount to work with during 1958, since it is little enough. The Mexican government, in addition, has assigned as center sub-director a young Mexican engineer, Guillermo Prieto, whom Polivka terms "invaluable."

Actually, while Mexico has lived up well to its role as host nation, it also stands to gain most from the school. ICAO does not sponsor scholarships for pilot training. As a result, practically all student pilots at the center are Mexicans. Students graduated from the 24-month commercial pilot course are qualified to begin as copilot with airlines. Some Mexican graduate pilots are now serving with Compania Mexicana de Aviacion, Aerovias Guest and Aeronaves de Mexico. Three graduates are serving as copilots on Aeronaves' Bristol Britannia 302s, which in December began operating non-stop to New York.

Pilot training is financed by the student's sponsors, either government or private. A coffee and cotton cooperative in El Salvador has sent several young men to take the 12-month agricultural pilot's training.

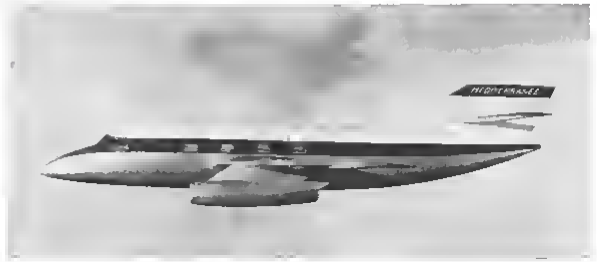
Cost for the commercial pilot's course is $6,400, for the agricultural pilot's course, $2,800.

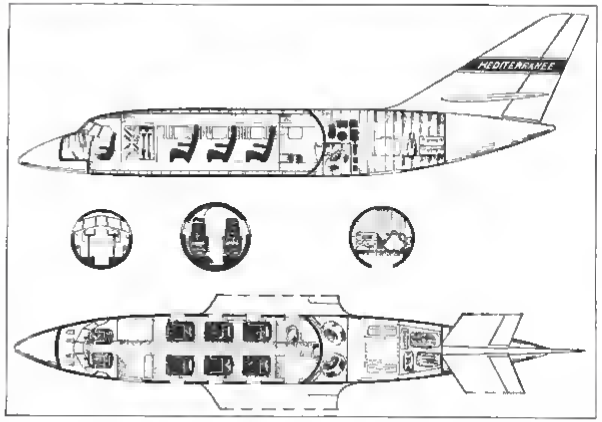
Pilots are given six to eight months in pertinent ground courses, then they move on successively to training in the Center's five Stearmans, four Beechcraft Mentors and two Piper Apaches. Instrument flying training is given in the center's two Link trainers.

All students must be a minimum of 18 years old. Ceiling for admittance to pilot training is 21 years, for others 30 years. Center was able to earn an extra $24,000 during 1956 through outside activities, among which was a special course given to 50 mechanics of the new engine overhaul and maintenance shop of Bristol de Mexico, a subsidiary of the Bristol Aeroplane Co. of Canada, Ltd. Moreover, it serves in an advisory capacity to Mexico's Civil Aeronautics Bureau and to branches of Mexico's commercial aviation industry.

Graduated students returning to their respective countries help train other aspirants to aid their nation's aviation industries. This is particularly important in the meteorological field where trained observers are lacking in Latin America.

Generally, through this school, flying in Latin America is expected to become safer and more efficient.





Farandole Jets Power Mediterranee

Two R.7 turbojet engines, designed by Avions Marcel Dassault and derived from Armstrong-Siddeley Viper jet, will power Dassault's Mediterranee executive jetliner shown in artist's drawing at top. Newly named the Farandole, the turbojet produces 3,000 lb. thrust and is podded under wings. Mediterranee's first flight is expected by end of 1958 (AW Jan. 6, p. 88). Aircraft will carry six to eight passengers and is designed primarily for use between France and African oil fields. Lower drawing shows six passenger design. Circular insets, from left, illustrate pilot's compartment, passenger section and baggage rack. Note aft position of main gear wheel well. Mediterranee will fly 1,200 mi. in 2½ hr.

Addison Airport, Tex., Expands IFR Service

Dallas—Civil Aeronautics Administration has approved omni-range approach procedures for Addison Airport, permitting round-the-clock instrument operation at the new executive airport.

Addison is equipped with a terminal VOR installed by Collins Radio Co.

TVOR is located so that the instrument approach heading parallels that of Dallas Love Field, eight miles to the Southwest. Love Field radar must be operating during simultaneous IFR approaches to both airports. When the radar is out, approaches to Addison will be assigned for minimum conflict with Love Field IFR traffic. Instrument clearances will come from Dallas Approach Control.

Addison will use 500 ft. and one mile as its minimums. Frequency for the TVOR is 111.4 mc., and its identification is ADS. It is at 32 58-24 latitude and 96 50-20 longitude.

Jetstar Passes Takeoff, Climb Test on One Engine

Lockheed Jetstar utility transport has successfully taken off and climbed from a standing start with one of its two Bristol Orpheus turbojets shut down. Takeoff was made from a field at 2,200-ft. altitude. Plane also has flown repeatedly at over 20,000 ft. on one engine, Lockheed reports. Twice during tests it has flown 1,725 mi. with ample fuel reserves remaining.

SAC Dispersal Fund Covers 29 Air Bases

Washington—USAF's new dispersal plan for Strategic Air Command contemplates the stationing of not more than 15 aircraft at each of 33 locations—six more than under the pre-Sputnik plan. The $549 million construction authorization bill passed by the House 374 to 0, authorizes construction for SAC dispersal at the following 29 installations:

Ellsworth AFB, Rapid City, S. D., $3.2 million.
Fairchild AFB, Spokane, Wash., $1.5 million.
Grand Forks AFB, N. D., $805,000.
Griffiss AFB, Rome, N. Y., $664,000.
Larson AFB, Moses Lake, Wash., $2.0 million.
Lockbourne AFB, Columbus, Ohio, $1.1 million.
Loring AFB, Limestone, Me., $1.5 million.
Malmstrom AFB, Great Falls, Mont., $672,000.
Minot AFB, Minot, N. D., $867,000.
Mountain Home AFB, Mountain Home, Idaho, $4.4 million.
Offutt AFB, Omaha, Neb., $690,000.
Pease AFB, Portsmouth, N. H., $1.7 million.
Plattsburg AFB, Plattsburg, N. Y., $1.1 million.
Westover AFB, Chicopee Falls, Mass., $2.4 million.
Kallu AFB, Valparaiso, Fla., $8.0 million.
Glasgow AFB, Glasgow, Mont., $29.0 million.
Kinross AFB, Sault Sainte Marie, Mich., $28.7 million.
K. I. Sawyer Airport, Marquette, Mich., $27.2 million.
Robins AFB, Macon, Ga., $3.0 million.
Wright-Patterson AFB, Dayton, Ohio, $22.6 million.
Wurtsmith AFB, Oscoda, Mich., $22.3 million.
Clinton County AFB, Wilmington, Ohio, $8.7 million.
Dover AFB, Dover, Del., $4.7 million.
Ernest Harmon AFB, Stephenville, Newfoundland, $2.2 million.
Goose Bay AFB, Labrador, $2 million.
McChord AFB, Tacoma, Wash., $5 million.
McGuire AFB, Wrightstown, N. J., $7 million.
Otis AFB, Falmouth, Mass., $7 million.
Selfridge AFB, Mount Clemens, Mich., $17.5 million.

The legislation also authorizes Semi Automatic Ground Environment (SAGE) construction at these sites:

Grand Forks AFB, Grand Forks, N. D., $170,000;
K. I. Sawyer Airport, Marquette, Mich., $277,000;
Larson AFB, Moses Lake, Wash., $50,000;
Luke AFB, Phoenix, Ariz., $12.6 million;
Malmstrom AFB, Great Falls, Mont., $0.9 million;
Minot AFB, Minot, N. D., $10.4 million;
Norton AFB, San Bernardino, Calif., $172,000;
Syracuse AFB, Syracuse, N. Y., $80,000.

1957 Sales and Earnings Up for Air Reduction Co.

Air Reduction Co., Inc., sales and earnings reached record highs in 1957, the firm recently reported.

Sales in 1957 were $189,987,698, an increase of 12% over 1956, the previous all-time high. Net income was $16,476,180, up 5% from last year.

Earnings per share of common stock in 1957 were $4.35.

WHO'S WHERE

(Continued from page 23)

Changes

Dr. Lloyd G. Mundie, research director of infrared projects, Systems Division, Bendix Aviation Corp., Ann Arbor, Mich.

Frederick J. Borheck, aviation sales manager, International Division, Bendix Aviation Corp., New York, N. Y.

G. D. Robertson, manager, Advanced Development Engineering Department, Government and Industrial Division, The Magnavox Co., Fort Wayne, Ind. **Walter G. Hawkins**, guided missiles advisory engineer of the newly formed Guided Missiles Department of the Government and Industrial Division.

Dr. James H. Klein, chief research engineer, Stanley Aviation Corp., Denver, Colo.

Dr. Fred P. Adler, manager, advanced planning staff, Systems Development Laboratories, Hughes Aircraft Co., Culver City, Calif.

Andrew C. Bayle, director of engineering, Waltham Precision Instrument Co., Waltham, Mass.

John Micheloth, director of operations, Clearing Machine Corp., division of U. S. Industries, Inc., Chicago, Ill.

Paul Helweg, assistant sales manager, Electronics Department, Hamilton Standard, division of United Aircraft Corp., Windsor Locks, Conn.

Alfred M. Salmon, United Air Lines resident representative at Boeing Airplane Co.'s Transport Division, Renton, Wash., ington.

Derek J. Lambert, assistant general manager (development), Vickers-Armstrongs (Aircraft) Ltd., Weybridge, England. Also **N. A. Barfield** and **C. Hanshaw Thomas**, senior development assistants to Mr. Lambert; **J. N. Montgomery**, senior development engineer, and **J. B. Armstrong**, senior operations engineer, Civil Aircraft Development Group.

R. N. Nielsen, director of newly organized Marketing Department, Grand Rapids Division, Lear, Inc., Grand Rapids, Mich. **V. E. Anderson**, assistant to Mr. Nielsen. Also, the following market managers have been assigned: **G. W. Rice**, military airplane products; **R. A. Robinson**, helicopter products; **R. V. Paolucci**, missile products; **L. K. Lear**, commercial aircraft products; **L. C. Deanehy**, maintenance support products.

Walter L. Flinn, staff director-defense activities (Washington, D. C.), Vickers, Inc., Detroit, Mich.

Hugh C. Bream, sales manager, Electronics Division, Rheem Manufacturing Co., Riverside, Calif. **Paul J. Linebarger** succeeds Mr. Bream as plant manager.

L. B. Richardson, Jr., chief of offsite flight operations (F8U-3 flight test and demonstration program), Edwards AFB, Chance Vought Aircraft, Inc., Dallas, Texas.

Douglas T. Cole, administrator of Pacific Stations and assistant to the executive vice president, Transocean Air Lines.

Arthur B. Williams, sales manager, Engineered Electronics Co., Santa Ana, Calif.

LEFT ENGINE AND WING (foreground) were torn from Martin 404, inverted on runway at Standiford (Louisville, Ky.) Airport.

CAB Accident Investigation Report:

Faulty Approach Cited in Landing Crash

Eastern Air Lines Flight 181, a Martin 404, N453A, was substantially damaged while landing at Louisville Kentucky on March 10 1957 about 1138[1] A small ground fire developed but was quickly extinguished One of the 31 passengers was seriously injured and five received minor injuries None of the three crew members was injured

HISTORY OF THE FLIGHT

Flight 181 originated at Midway Airport, Chicago Ill., for Miami Fla Several stops were scheduled including Indianapolis Ind., and Louisville Ky., the latter a point of crew change

Departure scheduled for 0955, was at 1001, with a crew of Capt Clarence G Chambers, Pilot Harold D Bingham and Stewardess Shirley Michael Th Indianapolis hs the flight was routine with Capt Chambers flying and arrival was on schedule

Departure from Indianapolis was on schedule, at 1105, with 31 passengers and 450 gal of fuel The aircraft's gross weight was 41,126 lb, 3,774 less than the maximum takeoff allowable of 44,900 and its center of gravity was located within prescribed limits Capt Chambers instructed Pilot Bingham to do the flying and accordingly Bingham seated on the right made the takeoff and flew this segment of the flight The aircraft proceeded along V 53 airway at 5 000 ft altitude on a VFR flight plan in clear weather

At 1133 the flight advised Standiford (Louisville) tower that it was over New Albany Ind., eight miles to the north northwest and requested clearance to the airport At 1134 the flight asked landing information of its company radio station and was given the Louisville pressure, altitude as 340 ft and the Louisville altimeter setting as 30 10 in A minute later the flight advised the tower that it was over the city and received clearance to land on runway 11 Wind conditions were given as southeast five to eight kt, variable both sides Ceiling and visibility were unlimited The "Fasten Seat Belt" sign had been put on

[1] All times herein are central standard based on the 24 hr. clock.

Pilot Starts Descent

Pilot Bingham descended from 5,000 ft to 2 000 ft and then reduced both rate of descent and power An airspeed of 165 kt was established, the landing gear was lowered and the flaps were placed in takeoff position Bingham then started a turn for final approach and the flaps were placed in approach position Captain Chambers saw that the aircraft was too high and reduced power still further, Bingham lowered the flaps to full down The prelanding check list had been accomplished

At this point (the altitude was then 1,000 to 1 500 ft higher than the runway) the captain took over control He nosed down sharply, holding as closely as possible to an airspeed of 100 kt The landing gear remained down, flaps remained fully down, and throttles were pulled full back Neither pilot read the rate of climb (descent) indicator during the approach

When approximately over the threshold of the runway and while about 100 ft above it the captain pulled back on the yoke to flare out No power was used The aircraft's attitude was observed to change from nose-down to nose-up but its rate of descent did not seem to lessen markedly The aircraft struck the runway on its main landing gear the left wing separated inboard of the left engine nacelle and the remainder of the aircraft half rolled to an inverted position It slid along in that attitude, turning and coming to rest headed nearly opposite its direction at touchdown

Two minutes later, by estimate all occupants were out of their inverted seats, in which they were belted and away from the wreckage which had developed a small fire This was confined by a passenger using a hand extinguisher until emergency apparatus, which had been alerted by the tower, arrived quickly and took the necessary steps to prevent further fire.

INVESTIGATION

Weather was excellent and was not a factor in this accident. Capt Chambers stated that the air was relatively smooth during the final approach and there was very little wind He was satisfied with the tower's advice to use runway 11 which was the active runway and is 5 000 ft long by 150 ft wide This runway was dry, smooth level, in good condition and its elevation is 497 ft

Investigation disclosed that there was no pertinent air traffic and that arrival at Louisville was on time actually a little ahead of schedule

As mentioned, the flight from Indianapolis was at 5,000 ft altitude in clear weather During this segment of which the total elapsed time was only 33 min the stewardess served luncheon to and removed trays from the 31 passengers Capt Chambers realizing that this would be a rather hurried operation allowed Pilot Bingham to maintain cruising altitude of 5,000 ft somewhat longer than he normally would. Chambers testified that there was a haze line with some choppiness at 4 500 ft and descending through it was delayed slightly to give the stewardess more time in smooth air This might account according to the captain, for arrival in the Louisville area while somewhat higher than usual. Capt Chambers also testified that the local noise abatement program, which imposes a minimum altitude over Louisville, four miles north of the airport was not a factor in the flight's altitude as it neared the airport

Both pilots stated that they could not sense any blowing back of the wing flaps during the approach These flaps incorporate a safety feature which allows a partial retraction from the full down position at airspeeds of 104 or more kt Both flaps and the landing gear were found fully extended with the landing gear in the locked position

Tire Marking Tracks

The first tire marks were made almost simultaneously by the left and right tires 242 ft from the approach end of the runway, with the left marks five feet inside the left edge of the runway Markings of the left tires were much more pronounced and wider than those of the right, indicating harder contact The left individual tire marks had a maximum width of 12½ in., those of the right tires were 11 in and both were within a few feet of their initial contacts A track made by the nose wheel tire began 36½ ft from the start of the left gear tracks and continued parallel to them for 59½ ft The Martin 404 nose wheel is 22 ft and 4 in forward of the main gear

Adjacent to the end of the nose wheel track was the first of 11 marks made by the left propeller blades This series of marks began with slight nicks which deepened further along the path Identifying marks made by the left wing were on the turf off the runway 340 ft beyond initial touchdown This area of flattish contact between left wing and turf was 5 ft by 14½ ft From this point forward, the tracks curved to the left running off runway 11 at a point 175 ft from the intersection of runways 11 and 6 then crossed the turf at the corner and onto runway 6 The distance from first contact to where the inverted fuselage came to rest is 1,080 ft About 150 ft from the fuselage was the left wing with left engine and left landing gear attached A short distance away the left propeller with its dome and the fractured left engine nose section stopped

Landing Gear

All landing gear shock struts were found to be properly serviced with air and oil This also was true of the main gear dampener struts Under test all shock struts operated freely after release of pressure Air pressure in the tires was checked and found to be as prescribed in the maintenance manual for the Martin 404

All cockpit controls and those continuing through the cockpit were found slack, due to aircraft damage But all were found to be properly connected and safetied and were continuous through their respective pulleys and fairleads

Examination of the entire wreckage revealed no evidence of failure or impairment of any component in flight It also disclosed that all components of the aircraft were present in the wreckage.

Examination of both propellers disclosed no evidence of any malfunctioning All blades were close to 30 deg of pitch which is normal when delivering no power En-

gines likewise were examined. Nothing was found in either to indicate any malfunctioning prior to contact.

Both airspeed indicators, both rate-of-climb indicators and the altimeters were examined in detail and found to have been functioning within acceptable limits.

All maintenance records were examined at the carrier's main overhaul base. These disclosed that maintenance of the aircraft, engines, propellers and related components had been conducted in accordance with the CAA-approved maintenance manual for Eastern Air Lines' Martin 404 aircraft. The last six flight reports (squawk sheets) for the aircraft carried no entries pertinent to this accident.

Eastern Air Lines acquired this aircraft new in February, 1952. Company records indicate that it had never been subjected to a landing hard enough, nor to turbulence severe enough, to demand an inspection for airworthiness since its acquisition, nor had it ever been involved in an accident.

Static Overload Failure

The left wing failed between the left nacelle and the fuselage. Examination indicated that the failure was of the static overload type and there was no evidence of fatigue. Examination further indicated that the initial failure was the shearing of one or both spar webs. This permitted both lower and upper caps of both spars to fail in secondary bending, whereupon the covers tore free and the entire wing became detached.

Sections from the two failed lower spar caps, front and rear, were examined by the National Bureau of Standards. The Bureau's report was summarized as follows:

"No evidence of fatigue was found on any of the fractures of the two spar caps. All the fractures were due to bending overloads.

"Samples of material from both spar caps complied with the requirements of reference (b) for tensile strength, yield strength, elongation and chemical composition. (Reference (b) is to Federal Specification (QQ-A-267) for 24S aluminum alloy extension. The spar cap material.)

The U. S. Weather Bureau altimeter setting at the airport at 1125, was 30.10 in. The aircraft's lower left altimeter was found set to a barometric pressure of 30.10 in. The captain's upper altimeter, as well as the first officer's, was at 340 ft. pressure altitude, which was the pressure given by the company radio a few minutes before the landing.

Unexpected Response

Capt. Chambers estimated that when he took the controls to complete the approach his altitude was 1,000 to 1,500 ft. above the runway. The horizontal distance from the approach end of the runway has not been determined with any degree of reliability, although the pilots thought it might be a mile or a mile and a half. The captain believed that his position was not enough out of the ordinary to warrant going around. He did not use power prior to starting the flareout because he thought it unnecessary to do so. He testified that when he pulled the control wheel back to flare out the response was not as expected.

A number of persons on the ground observed the approach and/or landing of this flight. One was in the airport parking lot office. His view was practically at right angles to the descent although he did not see the actual touchdown which was obscured by buildings. Another, the airport's Director of Operations, was in front of and on the airport side of the Administration building. Another was about 1¼ mi. north of the airport. Five controllers in the tower saw the approach and the runway contact. Their attention had been called to the unusually steep approach by the controller at local control position. Two men at the northeastern part of the airport also watched the approach. These 10 witnesses agree that the approach was steep, some describing it as extremely steep. Those who could see the runway contact concur that the attempted flareout for landing did not significantly check the downward speed, but that the aircraft struck the runway forcibly.

Statements were requested of the 31 passengers. 21 complied. Their consensus is that the flight from Chicago to Louisville with Indianapolis landing was normal and routine; that the approach to landing at Louisville was steep, and that the contact was hard. Most thought the air was smooth although a few thought otherwise. As mentioned, the captain testified that the air was relatively smooth during approach. In regard to the steepness of approach, passengers described it variously as "articles slid from my lap," "nose pointed straight down," "seemed to be going straight down" and "the sink rate seemed to be excessive," the last by an Air Force officer.

The theoretical angle and rate of descent

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under the conditions as testified to by the captain has been computed. With no wind, full flaps, landing gear down, a sustained 100 kt. indicated airspeed, throttles fully retarded and a gross weight of 40,700 lb. which makes due allowance for fuel burnoff, the angle should have been 11 deg. from the horizontal with the aircraft's longitudinal axis depressed six deg. below the 11-deg. slope line. The rate of descent would have been about 1,800 fpm.

Shortly after the accident Capt. Chambers flew another Eastern Martin 404 at high altitude, simulating the conditions of the actual approach. Pilot Bingham accompanied him as observer. According to the captain, this test with the aircraft grossing nearly as much as the crashed one, and with other conditions the same, full flaps, landing gear down, throttles kept fully back and maintaining 100 knots airspeed, resulted in a rate of descent of 1,950 fpm. (32.5 fps.)

Eastern Air Lines' training curriculum does not specifically prohibit this type of steep approach with power off during flare out and landing. But company officials were emphatic in testifying that such a technique is contrary to pilot training methods as explained orally and as demonstrated in flight. Capt. Chambers' last previous company flight check was passed with a grade slightly better than average. His earlier checks and grades also were consistently satisfactory. During the three months preceding this accident he had flown Martin 404s exclusively, a total of 245 hr. He was thoroughly familiar, from long experience with Standiford Airport. Chambers and Bingham had flown together for 229 hr.

ANALYSIS

All evidence indicates clearly that the wing failure was the result of, and not the cause of, this accident. The wing structure was intact throughout the flight and landing approach and did not separate until the aircraft had contacted the runway. Tests conducted on the pertinent parts disclosed no prior fatigue cracking and/or material defects, and it was established that the fractures were produced by excessive loads. Further, an engineering review of the manufacturer's technical data disclosed no discrepancies in this regard and that appreciable strength margins were provided in the design of the structure in the failed area. Failure of the wing structure prior to and/or without a failure of the main landing gear was a clear indication that high vertical loads such as would accompany a hard landing had been imposed on the structure.

In exploring why the aircraft had contacted the runway as hard as it did, the Board gave careful consideration to the captain's statement that the aircraft's response was not as expected when he pulled back on the yoke in an attempt to flare out. The various components of the elevator and movable stabilizer control system were thoroughly examined for failures or malfunctioning evidence but none was found. Furthermore, no other complaints against the subject control systems had been received. Moreover, the elevators did function properly throughout this landing, as indicated by the fact that the captain's displacement of the elevators caused the aircraft's nose down descent angle to change to a nose up angle at touchdown.

However, the change in attitude was too

late to check the high rate of descent sufficiently, and the aircraft contacted the runway extremely hard. If the flareout had been started sooner, or if sufficient power had been applied just prior to and during the flareout, the excessive rate of descent might have been controlled and the hard landing with its resulting damage avoided.

Normally, Pilot Bingham who flew the Indianapolis-Louisville segment would have made the approach and landing. In this case Capt. Chambers erroneously allowed Bingham to bring the aircraft to a position much too close in considering the altitude for the planned landing on runway 11. At that position relative to the runway, Chambers should have taken control and circled the airport to establish a normal approach or instructed Bingham to do so.

Steep Descent Angle

But the captain did not do this. Instead he elected to dive steeply with full flaps and no power. The precise angle of descent is not known but the preponderance of testimony is that it was exceedingly steep. This testimony is largely by well-qualified witnesses. Such an approach would require in order safely to check an abnormally high rate of descent a much earlier starting of the flareout with the use of such power as might be needed to maintain a safe margin of speed.

There was no urgency whatever because of other traffic, weather, lateness in arrival or any other compulsive factor, in pressing this approach and landing. Further, this flight crew was to have been relieved at Louisville. This type of approach is in conflict with general and long established airline training and practice. Because no other factors were involved in this accident and no alleviating circumstances stand forth, the Board can only conclude that the pilot erred in executing this type of approach and touchdown. Specifically, the approach was too steep, the flareout was ineffective because of the low airspeed, and consequently the landing was destructively hard.

FINDINGS

On the basis of all available evidence the Board finds that:

1. The carrier, the aircraft, and the crew were properly certificated.
2. There was no irregularity in the functioning of the aircraft nor of any of its components.
3. Weather, radio facilities, or other traffic were not involved.
4. An approach was started from a point too close and too high in relation to the approach end of the runway.
5. The speed and configuration of the aircraft in connection with the retarded throttle during this approach resulted in an inordinately high rate of descent.
6. This high descent rate was not sufficiently checked during the attempted flareout.
7. Touchdown imposed loads beyond the design strength of the wing structure, which failed.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was the captain's faulty landing approach technique, resulting in an excessively high rate of sink at the instant of touchdown, imposing load beyond the design strength of the wing structure.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
C. Joseph Nemeth
Louis J. Hector

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident at 1315, March 10, 1957. Investigation was started immediately in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. Depositions were taken at Chicago, Ill., on May 15, 1957, at Louisville, Ky., on May 16, 1957, and at Miami, Fla., on May 17, 1957.

Eastern Air Lines, Inc., is a Delaware corporation maintaining its main office at New York, N. Y. The company has certificates of public convenience and necessity issued by the Civil Aeronautics Board and air carrier operating certificates issued by the Civil Aeronautics Administration authorizing the carriage by air of persons, property, and mail over the route involved in this accident.

Flight Personnel

Capt. Clarence C. Chambers, age 33, had been employed by Eastern Air Lines since August 1949. He held all necessary certification and ratings for the subject flight. His total flying time was 7,795 hr., of which 2,151 hr. had been in Martin 404's. His test period prior to departing Chicago on the subject flight was 24 hr. 40 min. During the previous 30 days he had flown 40.4 hr., during the previous 90 days, 245 hr. He had flown no other type of aircraft during that 90-day period. His physical examination and line check were current.

Pilot Harold D. Bingham, age 31, was first employed by Eastern in September, 1949. He became a pilot for the company in March 1956, and was properly certificated and rated for the subject flight. His total piloting time was 1,201 hr., of which 652 had been in Martin 404's. Mr. Bingham's test period prior to the subject flight was more than 48 hr., and his physical examination and line check were current. Bingham and Chambers had flown together for 29 hr.

Stewardess Shirley Michiel had been employed by Eastern since October 1955 and had satisfactorily completed the company's required training courses.

The Aircraft

N453A, Martin 404, was acquired new by Eastern Air Lines in February 1952. At the time of this accident its total operational time was 15,365 hr. Records of its maintenance and overhauls indicated that both had met all CAA and company requirements.

Engines were Pratt and Whitney, model R2800-CB-3. These engines had total times of 9,530 and 9,971 hr. and times since overhaul of 782 and 1,079 hr. for left and right, respectively.

Propellers were Hamilton Standard, model 43E60-7. Their total operational times were 13,714 and 14,075 hr., with 1,585 and 1,405 hr. since overhaul, for left and right, respectively.

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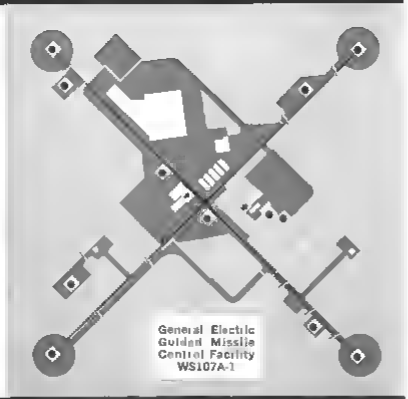

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LETTERS

Splendid Job

We at Vertol have anxiously reached for AVIATION WEEK on the past few Mondays to find out how Mr Farrell had reacted to his visit to the French forces in Algeria

I think I can speak for most of us in saying that Mr Farrell has done a splendid reportorial job on the subject this year just as he did in the summer of 1956

What Mr Farrell had to say about the French Army's use of the H 21 squares well with what we have learned in our experience with the French forces

Since the Algerian operation is the first real combat experience for modern helicopters, I feel that you have done a real service to the industry with this series

DON R BERLIN
President
Vertol Aircraft Corp
Morton, Pa

Wind Tunnel Tests

Your excellent article on the use of wind tunnels for the development of protective clothing (AW Dec 30, p 83) provided a good illustration of the versatility and adaptability, as well as of dollar and time economy, of wind tunnels to assist in the solution of a wide range of problems

The statement, however, indicating that it was necessary to stop all other wind tunnel operations in order to accommodate the Martin program is not entirely accurate The seven test units of the Engine Test Facility, in one of which this test was conducted, share a common air supply plant When large air flows are demanded, as in the case of this test it is necessary to divert the entire plant supply to the demanding test unit—but only for the duration of that test Since the Martin test required only a short burst of air, the total test time lost to other test units was very nearly negligible None of the other wind tunnel facilities of the AEDC were affected by this testing

J M WILD
Director of Engineering
Aro Inc.
Tullahoma, Tenn.

Wasting Millions

Congratulations to Mr James Ranck (AW Dec 30, p 102) The comments regarding the engineering situation are true I can talk about it because I came from Europe because I have been working with hundreds of "engineers" and because I have changed jobs four times in two years of residence in this country. The reason? I like work, and I become immediately an undesirable person According to what I have been able to see, there are in this country more engineers doing nothing than those that really work Take one of the last places in which I worked—my boss was a school teacher, he was in charge of research and you should see him giving orders to Ph Ds, and speaking from all day, from morning to night, about physics laws, thermodynamics, politics, women, statistics, or anything that you want to know The gun that has one idea will be in one corner for life No one except himself will sign a report or present one idea In this way the country is wasting millions In how many places I have seen one research job in the hands of several individuals—everyone is doing the same thing everyone is making the same mistakes, or doing everything possible to avoid that others look at his work Like enemies

It's true that millions are needed to improve educational standards but until the psychological aspects are solved most of the money spent will be wasted

Research and development are fundamental and require maximum attention by management Leave the research and development department in the hands of ignorant people and sooner or later you can close your plant

JOHN R ATELLI
Boston Mass

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Need More Jobs

In reference to the letter "Inactive Engineers" (AW Dec 30 p 102) I heartily agree with the article I think instead of more engineers we need more and better jobs for those we have

I would also like to cast my vote for better education I am at present employed in the service of the USAF, and feel that my time is wasted

LT LAURENCE MEYER
Albuquerque, N M

Smoke Screen

I agree with Mr James Ranck ("Inactive Engineers" AW Dec 30 p 102), there is no shortage of engineers This country is not faced with a need for more engineers instead we need better managment of those we have Why are so many competent engineers doing detail or routine work that can be handled by draftsmen and high school graduates? In my opinion the so called engineering shortage is a smoke screen to cover up this misuse by industry and the armed services

MILTON L RICE
Rancho Cordova, Calif

'Shortage' Picture

Reference is made to James Ranck's letter concerning the "Engineering Shortage" printed on the Letters page of your Dec 30 issue

The results of recent studies made for the Engineers Joint Council and the National Science Foundation showed that the average engineer's salary was $6,216 per year, and that he had to work for 10 years following graduation to catch up with the pay rate of a plumber or bricklayer These are hardly indications of any shortage, based upon the only true measure of shortage in our supply and demand economy

It has been said that engineers have been given all sorts of non engineering jobs to do simply because they do any job well—even though it may be not in their best professional interest or development This would seem to explain the cause of any claimed general shortage

If engineers were available at even cheaper rates which would permit their economical use as sweepers, the "shortage" picture could be tremendously expanded

Count me in with Ranck!

THOMAS W PHILLIES
Phoenix, Ariz

Misplaced Computer

My Dad and I regularly read your interesting magazine and particularly enjoy and admire your penetrating and courageous editorials

Although I am a ninth grade student at Flintridge Prep in Pasadena and, therefore perhaps not qualified to criticize your usually completely accurate publication I would like to ask about a picture heading on p 105 of the Dec 16 edition of your magazine which appears to me to be in error

The item in question is the caption "F 106 Computer " It has been my understanding as witness your inside front cover ad and caption, that the F-106 has its air intakes several feet aft of its canopy It appears to me that the picture on p 105 is that of an F 102 with its instrument hatch open However the caption designates the airplane as an F-106

Would you please inform me whether I am correct? My Dad and I fly together quite often in our Beech Twin Bonanza, and I like airplanes and your magazine.

TONY ACKER
Pasadena, Calif

Is AVIATION WEEK slipping on aircraft identification? In your Dec 16 article "F 106 Computer Navigates, Intercepts," (p 105), you state that the computer has undergone flight test in an F 102, and the accompanying picture is that of an F 102 However the caption under the picture somewhat ambiguously relates computer function in an F 106

Did AVIATION WEEK goof, or was the 102 actually supposed to be there?

Any self respecting delta wing admirer could spot the difference (even in this chipped photo) as 106 intake ducts begin farther back along fuselage, nearer wing leading edges whereas 102 intake ducts are practically in line with windscreen (See Convair ad inside front cover same issue) Just thought I'd check Really enjoy my AVIATION WEEK subscription Keep on giving us the best magazine of its type.

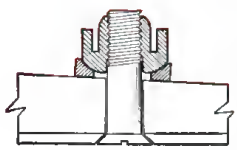
CHARLES BARENSFELD
TWA Copilot—ANG Weekend Jet Type
Livonia Mich

(Airplane shown was an F 102, computer will be used in the F 106.—Ed.)

How ESNA® solves 7 typical aircraft fastening problems

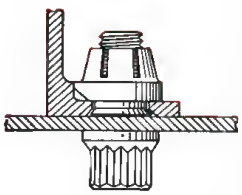
Speedier installation of access panels

ESNA gang channel nut strips eliminate the costly, time consuming installation job of riveting individual nuts. Available in straight or curved sections and even complete rings, custom designed for applications such as access doors or inspection covers.



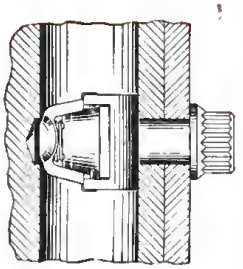
Bolting non-parallel surfaces

No more costly spot facing, step milling or hand selecting tapered shims! ESNA's counterbored, self-aligning types include one lug, two lug, gang channel, standard hex and high tensile types. Ball-and-socket relationship of nut and special base allow an 8° tilt in any direction from centerline to compensate for draft angle or tapered sections.



Fastening stressed joints subject to temperatures up to 1300°F.

For really "hot" applications such as jet engine flange assemblies or fire wall sections, where fastener dependability is critical, ESNA offers the "long-beam" locking device. The full cantilever of these sections assures protection against failures related to relaxation, creep and similar problems caused by the effects of extremely high temperatures upon metals. **(Ask for ESNA Bulletin No. 5715 Design Manual for High Temperature Self-Locking Nuts.)**



Simplifying major substructure joining

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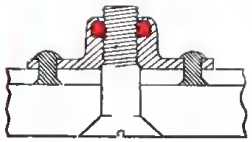

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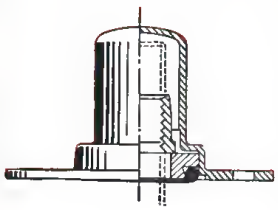
Attaching components in areas with limited wrench clearance.

Miniaturized insert-type hex nuts with across-the-flats dimensions as small as .109 in the 0-80 size . . . or all metal (550°F.) nuts to AN365 or NAS 679 performance specifications with internal wrenching hexagon faces (which permit use of smaller wrench sizes) are available for use at locations where space and weight limitations are paramount. Complete lines of NAS miniature anchor nuts in carbon steel and A286 stainless steel are also in production. **Ask for your copy of the NAS/ESNA Conversion Book.**



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